



Pacific Operational Science & Technology Conference

2-4, April 2007

Honolulu, HI

Agenda

Tuesday, 3 April 2007

Current Theater Environment – FY07-FY09

HQ USPACOM

- **USPACOM J2**, “*Intelligence Prospective*”, RADM Andrew M. Singer, USN, Director for Intelligence, J2, US Pacific Command
- **USPACOM J4**, “*Logistics, Engineering, and Security Assistance (J4)*”, Brigadier General Kenneth S. Dowd, USA, Director for Logistics, Engineering and Security Assistance, J4, US Pacific Command

Homeland Security Perspective:

- **Department of Homeland Security**, “*DHS Science & Technology: Alignment for Success*”, Rear Admiral, (Retired), Jay Cohen, USN, Under Secretary for Science & Technology

International Perspective:

- **Australia**, “*Current Theatre Environment An Australian Perspective*”, Dr. Roger Lough, Chief Defense Scientist, Defence Science and Technology Organization
- **Singapore**, “*Security challenges from the perspective of a small city state*”, Rear Admiral (Retired) Richard Lim, Chief Executive, Defence Science and Technology Agency
- **Republic of Korea**, “*Perspective on S&T Collaboration*”, Dr. Tae In Choi, Vice President, Agency for Defense Development

Banquet w/Special Guest Speaker:

“*Breakthroughs, the Product of Innovators*”, Mr. Burt Rutan

Wednesday, 4 April 2007

Near Term Solutions to Current Challenges – How the World will Change: FY07-FY09

Military Services Research and Development

- **Army Research and Development**, “*Army Science & Technology Overview*”, Dr. Thomas H. Killian, Deputy Assistant Secretary for Research & Technology/Chief Scientist, Department of the Army.
- **Navy Research Enterprise**, “*Naval Science and Technology Update*”, Rear Admiral William E. Landay, III, USN, Chief Naval Research
- **Air Force Research and Development**, “*Solutions to Current Challenges: FY07-FY09*”, Major General Ted F. Bowlds, USAF, Commander, Air Force Research Laboratory

DoD Agency Research and Development

- **DARPA**, “*DARPA Networking and Communications Overview*”, Dr. Larry B. Stotts, Deputy Director, Strategic Technology Office, DARPA

- **OSD/Nuclear, Chemical, Biological**, “*Nuclear, Chemical and Biological Defense Research and Development*”, Dr. Thomas Hopkins, Acting Assistant to the Secretary of Defense (NCB)

Lunch w/Guest Speaker:

“*Strategic Challenges in the Asia-Pacific Area*”, Lieutenant General (Retired) E.P. Smith, USA, Director, Asia-Pacific Center for Security Studies

Industry Panel:

Panel Members:

- **ISR-UAVs, Future Solutions – ISR**, Mr. John Grabowsky, VP & GM – Small UAVs, AeroVironment
- **Maritime Domain Awareness**, “*Future Industry Solutions....FY10 and Beyond*”, Mr. Tom Williams, VP Advanced Concepts, Integrated Systems Sector, Northrop Grumman Corporation
- **Undersea Warfare**, “*Undersea Warfare*”, Mr. Roger Bagbey, SVP & Group Manager – Engineering and Technology Center, Alion Science & Technology

Game Changing Technology Panel

Panel Topics:

- **Knowledge Management – from SA to BDA**, “*Connecting the Dots*”, Lieutenant General (Retired) George Fisher, USA, Director, Department of Defense Programs, National Security Directorate, Oak Ridge National Laboratory
- **Computational Imaging**, “*Game Changing Technologies, Computational Imaging Systems*”, Dr. Timothy Persons, Technical Director, Disruptive Technologies, ONI
- **FiberWeb Linear Sensor**, “*The ATLAS, Powered Rope Ascender*”, Major Rex Blair, USA and Mr. Nathan Ball, MIT Institute for Soldier Nanotechnologies



Pacific Operational Science & Technology Conference

*April 2-4, 2007
Hilton Hawaiian Village
Mid-Pacific Conference Center,
Coral Ballroom*



**Pacific Operational
Science & Technology Conference**
Hilton Hawaiian Village
Mid-Pacific Conference Center
Coral Ballroom

Monday, April 2, 2007

5:00 PM – 6:30 PM Registration and Ice Breaker Reception
Exhibit Hall, Coral Lounge

5:00 PM – 6:30 PM Exhibits Open, Coral Lounge

Tuesday, April 3, 2007

Coral Ballroom IV

Pacific Theater Environment: Today and Beyond

7:00 AM – 8:00 AM Registration Open / Continental Breakfast
Exhibit Hall, Coral Lounge

7:00 AM – 8:00 AM Exhibits Open
Coral Lounge

7:20 AM **Administrative Remarks / Conference Overview**
Dr. Charles H. Kimzey, PhD
Science & Technology Advisor, U.S. Pacific Command

7:30 AM **Commander's Overview**
Lieutenant General Dan Leaf, USAF
Deputy Commander, U.S. Pacific Command

Current Theater Environment – FY07 – FY09

HQ USPACOM

8:00 AM **USPACOM J2**
RADM Andrew M. Singer, USN
Director for Intelligence, J2, U.S. Pacific Command

8:15 AM **USPACOM J3**
Brigadier General Martin Post, USMC
Deputy Director for Operations, J3, U.S. Pacific Command

8:30 AM **USPACOM J4**
Brigadier General Kenneth S. Dowd, USA
Director for Logistics, Engineering and Security Assistance, J4, U.S. Pacific Command

8:45 AM **USPACOM J5**
Rear Admiral Michael C. Tracy, USN
Director for Strategic Planning & Policy, J5, U.S. Pacific Command

9:00 AM Panel Discussion
Chair: Rear Admiral Michael C. Tracy, USN
Director for Strategic Planning and Policy, J5, U.S. Pacific Command

9:20 AM Break
Coral Lounge

Pacific Operational Science & Technology Conference

Homeland Security Perspective

9:40 AM **Department of Homeland Security**
Rear Admiral, USN, (Retired), Jay Cohen
Under Secretary for Science & Technology

International Perspective

10:10 AM **Australia**
Dr. Roger Lough
Chief Defence Scientist
Defence Science and Technology Organization

10:35 AM **Singapore**
Rear Admiral (Retired) Richard Lim
Chief Executive, Defence Science and Technology Agency

11:00 AM **Republic of Korea**
Dr. Tae In Choi
Vice President, Agency for Defense Development

12:00 PM Lunch - Coral Ballroom V
Keynote Speaker
Lieutenant General Dan Leaf, USAF
Deputy Commander, U.S. Pacific Command

1:30 PM – 7:00 PM Exhibits Open

LISTEN UP! Warfighter's Perspective

1:30 PM CAPT Kirk Brinker, SOCPAC
SGM William Smith, USA, HQ USARPAC G357
EODCS Michael Lentz, USN, EOD MU Five
CSM Elroy Alcivar, USA, RDCOM
SSG Keith Frain, USA, Tripler Army Medical Center
SFC Kevin Kennedy, USA, SOCPAC
SGM Errol Snyder, USA, 1-21 1-21 Infantry, 25th ID
SFC Mario Miramontiz, USA, 1-21 Infantry, 25th ID
SGM George Garcia, USA, 1-21 Infantry, 25th ID
SMSgt John Anipe, USAF, 25th Air Support Operations Squadron
SSG Tanner Catrett, USA, 706th EOD
SSG Brad Joehen, USA, 706th EOD

2:30 PM **Panel Discussion**
Chair: Sergeant Major William T. Kinney, Senior Enlisted Leader,
U.S. Pacific Command

2:50 PM Break
Coral Lounge

Pacific Operational Science & Technology Conference

"Over The Horizon" Theater Challenges – FY10 and Beyond

3:10 PM Panel Members: **General Larry D. Welch, USAF (Retired)**
*CEO Institute for Defense Analysis and
Former Air Force Chief of Staff*

General Charles R. Holland, USAF (Retired)
Former Commander, U.S. Special Operations

Admiral Thomas B. Fargo, USN (Retired)
*President, Trex Enterprises Corporation and
Former Commander, U.S. Pacific Command*

Panel Chair: **General Larry D. Welch, USAF (Retired)**
*CEO Institute for Defense Analysis and
Former Air Force Chief of Staff*

| | |
|---------|---|
| 5:30 PM | Pre-Dinner Social – Exhibit Hall <i>Exhibit Hall, Coral Lounge</i> |
| 6:00 PM | Banquet w/Special Guest Speaker – Mr. Burt Rutan <i>Coral Ballroom V</i> |

Wednesday, April 4, 2007

Solutions to Theater Challenges *Coral Ballroom IV*

| | |
|----------------|--|
| 7:00 AM | Registration Open / Continental Breakfast <i>Exhibit Hall, Coral Lounge</i> |
| 7:00 – 8:00 AM | Exhibits Open |
| 7:50 AM | Administrative Remarks / Program Overview <i>Dr. Charles H. Kimzey, Science & Technology Advisor U.S. Pacific Command</i> |

Near Term Solutions to Current Challenges - How the World will Change: FY07-FY09

Military Services Research and Development

| | |
|----------|---|
| 8:00 AM | Army Research and Development <i>Dr. Thomas H. Killion Deputy Assistant Secretary for Research & Technology / Chief Scientist, Department of the Army</i> |
| 8:45 AM | Navy Research Enterprise <i>Rear Admiral William E. Landay, III, USN Chief of Naval Research</i> |
| 9:30 AM | Air Force Research and Development <i>Major General Ted F. Bowlds, USAF Commander, Air Force Research Laboratory</i> |
| 10:15 AM | Break |

Pacific Operational Science & Technology Conference

10:35 AM Panel Discussion –
"How the research community can be more responsive to the Warfighter needs."
Chair: Mr. Vincent Vitto
President & CEO, Charles Stark Draper Laboratory, Inc. and
Vice Chairman, Defense Science Board

DoD Agency Research and Development

11:20 AM **DARPA**
Dr. Larry B. Stotts
Deputy Director, Strategic Technology Office, DARPA

12:00 PM **OSD/Nuclear, Chemical, Biological**
Dr. Thomas Hopkins
Acting Assistant to the Secretary of Defense (NCB)

12:30 PM Lunch w/Guest Speaker - Coral Ballroom V
"Strategic Challenges in the Asia-Pacific Area"
Lieutenant General E.P. Smith, USA (Ret)
Director, Asia-Pacific Center for Security Studies

1:30 PM – 4:00 PM Exhibits Open

Future Industry Solutions – FY10 and Beyond

1:45 PM Industry Panel

Panel Members: **ISR - UAVs**
Mr. John Grabowsky
VP & GM - Small UAVs, AeroVironment

Air & Missile Defense
Mr. Dave Kier
VP & Managing Director - Protection
Lockheed Martin Corporation

Maritime Domain Awareness
Mr. Tom Williams
VP Advanced Concepts, Integrated Systems Sector
Northrop Grumman Corporation

Undersea Warfare
Mr. Roger Bagbey
SVP & Group Manager - Engineering and Technology Center
Alion Science & Technology

2:45 PM Panel Discussion

Panel Chair: **Dr. Ray O. Johnson**
SVP & CTO, Lockheed Martin Corporation

Pacific Operational Science & Technology Conference

Game Changing Technologies – Significant Future Operational Solutions

3:05 PM **Game Changing Technology Panel**

Panel Topics: **Nano Technology - How Small Can You Go?**

Dr. Susan E. Durham

Coordinator for Nanotechnology

Intelligence Technology Innovation Center

Knowledge Management - from SA to BDA

Lieutenant General George Fisher, USA (Retired)

Director, Department of Defense Programs,

National Security Directorate, Oak Ridge National Laboratory

Computational Imaging

Dr. Timothy Persons

Technical Director, Disruptive Technologies, ONI

Directed Energy

Dr. Kirk E. Hackett

Air Force Research Laboratories, Kirtland AFB

FiberWeb Linear Sensor

Major Rex Blair, USA and Mr. Nathan Ball

MIT Institute for Soldier Nanotechnologies

Panel Discussion

Panel Chair: **Mr. Vincent Vitto**

President and CEO, Charles Stark Draper Laboratory, Inc.

and Vice Chairman, Defense Science Board

4:00 PM Exhibit Hall Closes

4:35 PM Adjourn

LOGISTICS, ENGINEERING, and SECURITY ASSISTANCE (J4)



***BG Dowd, PhD
USPACOM J4
3 APR 2007***

This brief is classified:
UNCLASSIFIED

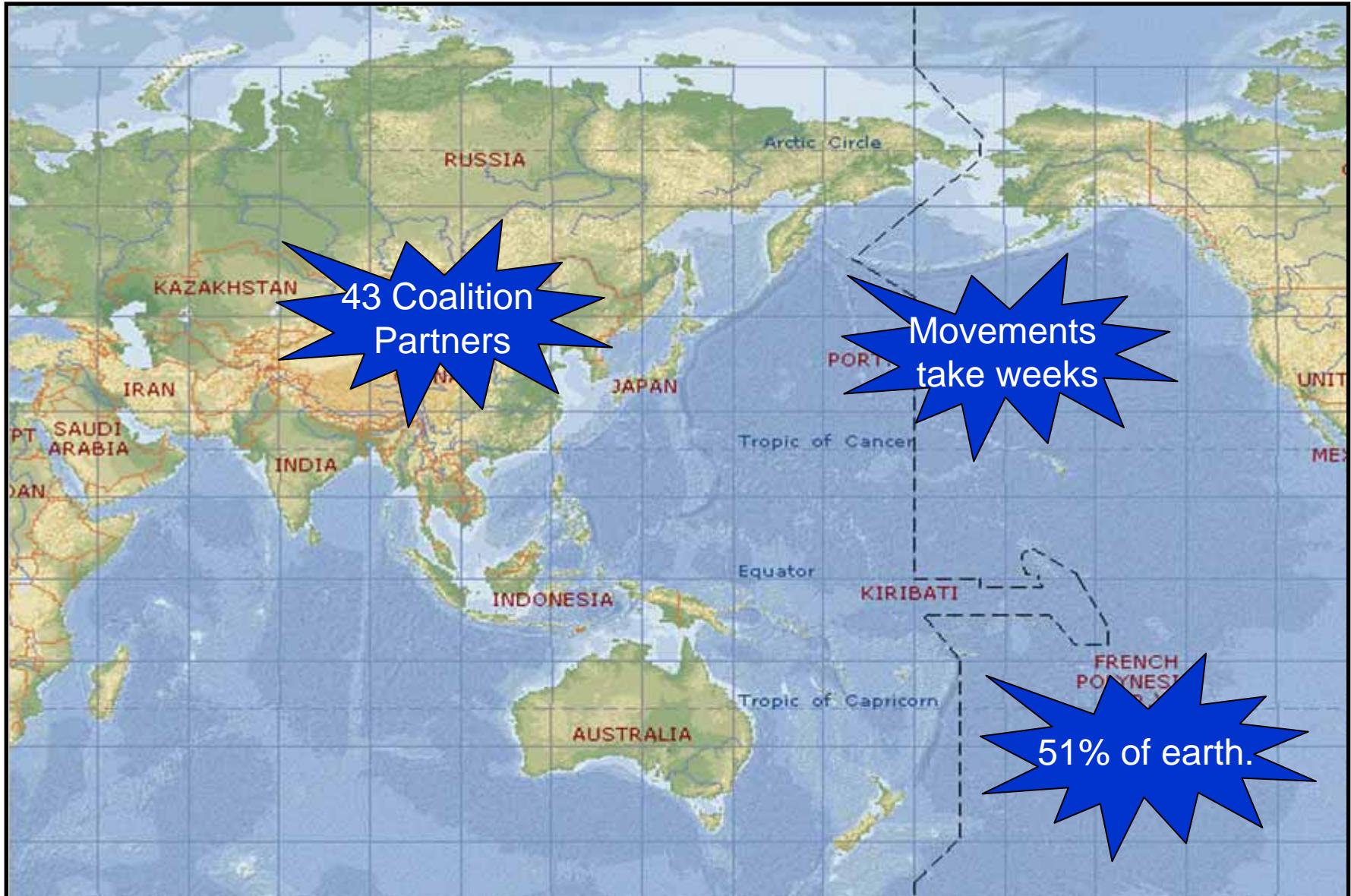


Agenda

- The Environment
- The Challenge
- Discussion



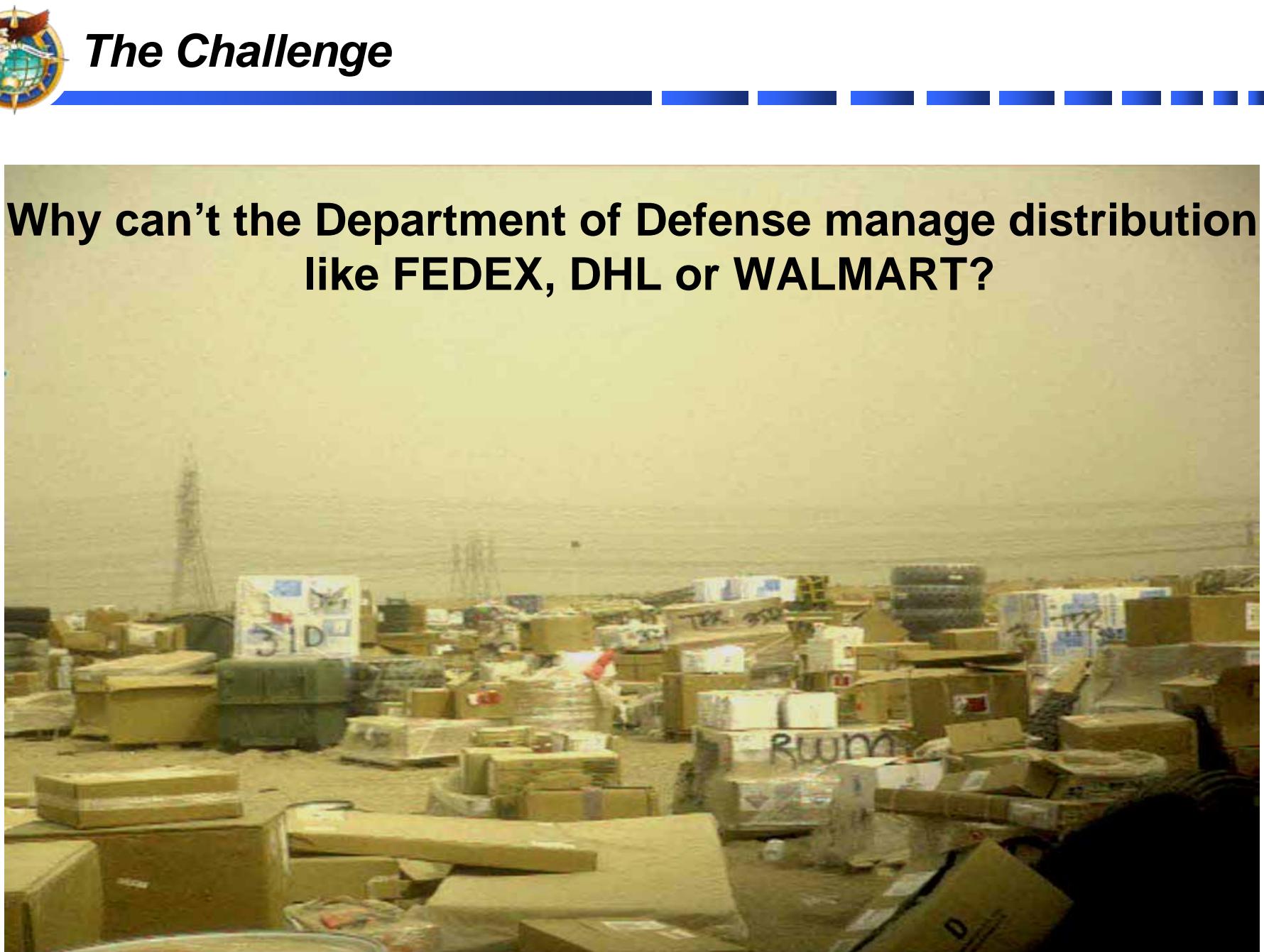
The Environment





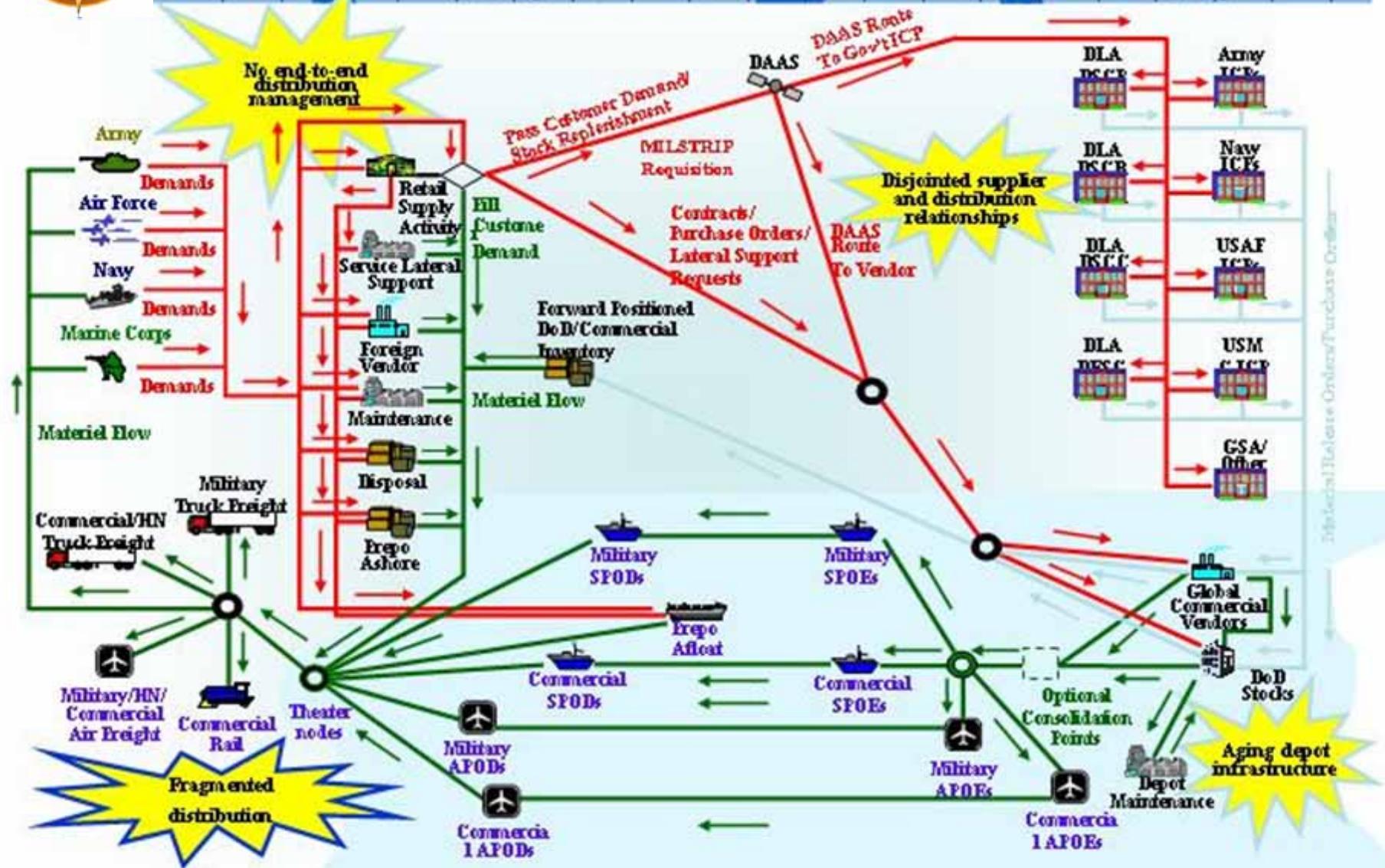
The Challenge

Why can't the Department of Defense manage distribution like FEDEX, DHL or WALMART?





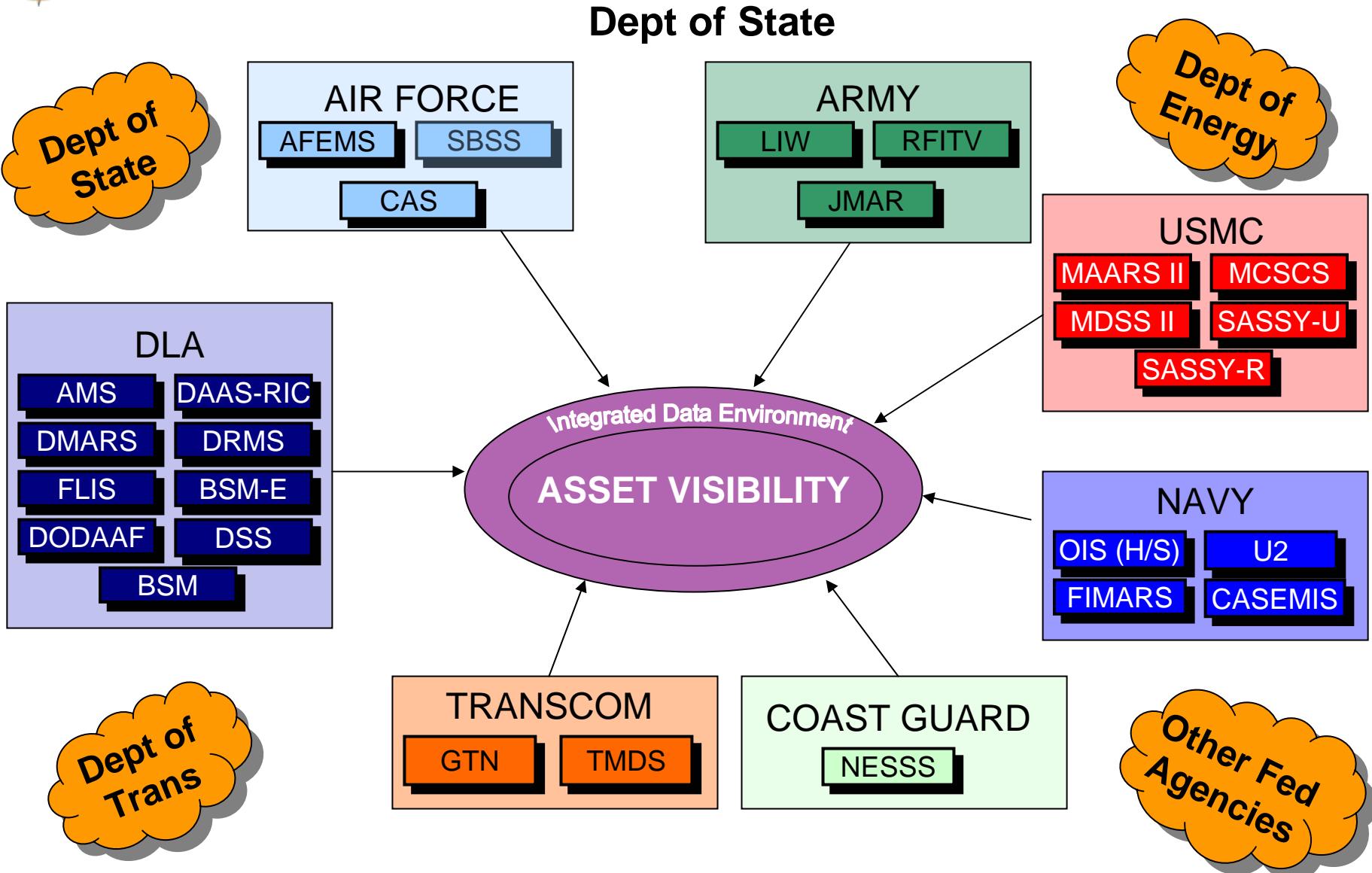
Distribution Challenge



Does not include AFFES, DECA, Mail, FEDEX/DHL, LOGCAP/Contractor!



The Automation Challenge – too many systems





Thoughts

- Money spent on Log Automation \$\$\$\$.
- Stop Stovepipes
- Joint Funding
- Joint Solutions



DARPA Networking and Communications Overview

5 April 2007

Dr. David Honey
Director, STO
571-218-4247
david.honey@darpa.mil

Dr. Larry Stotts
Dep Dir, STO
571-218-4346
larry.stotts@darpa.mil

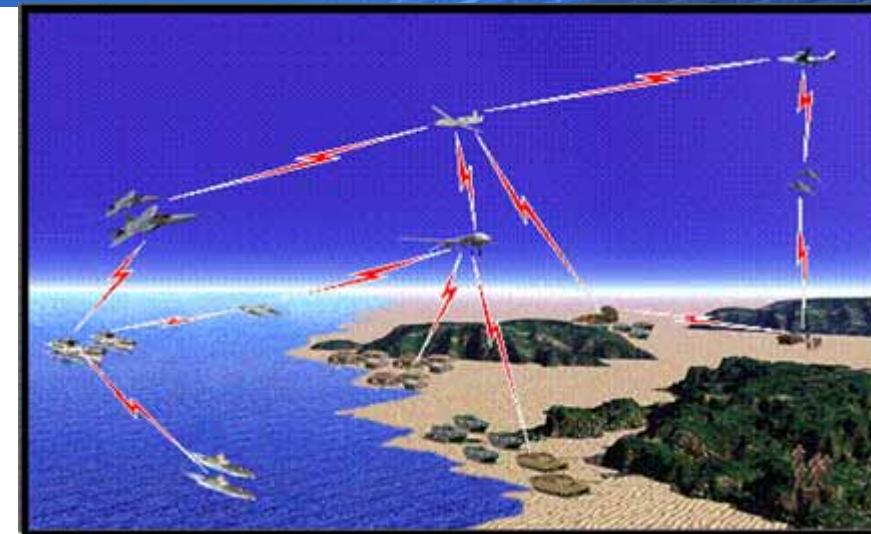
Dr. Brian Pierce
Dep Dir, STO
703-248-1505
brian.pierce@darpa.mil

Military Operations Structure

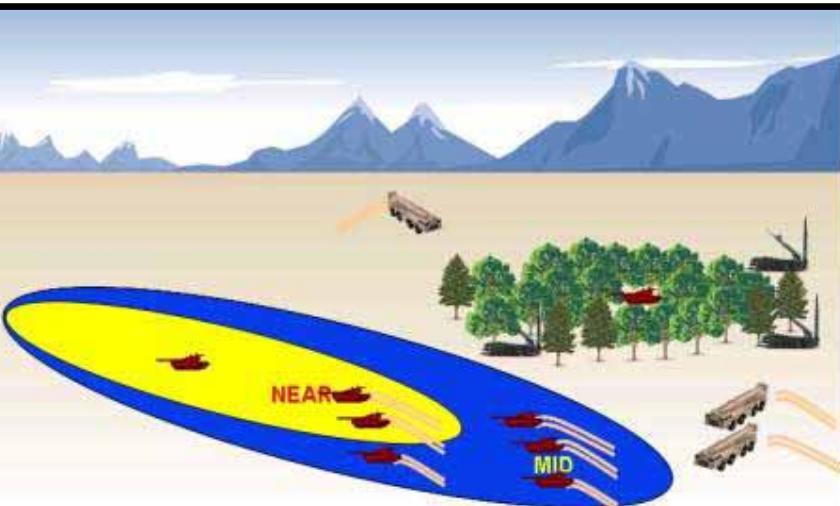
Network Centric Enterprise

Strategic and operational level of deployment and warfare

- Cleared Personnel – TS/SCI
- Links air, ground and naval campaigns
- Engages by operational maneuver and strategic strikes
- Provides information, resources, and sustainment connectivity
- Large C4ISR backbone and infrastructure
 - Rides on GIG and Extensions
 - Can leverage commercial info systems
 - IPv6 early adopter
 - Susceptible to many IA threats



Bridge the Gap



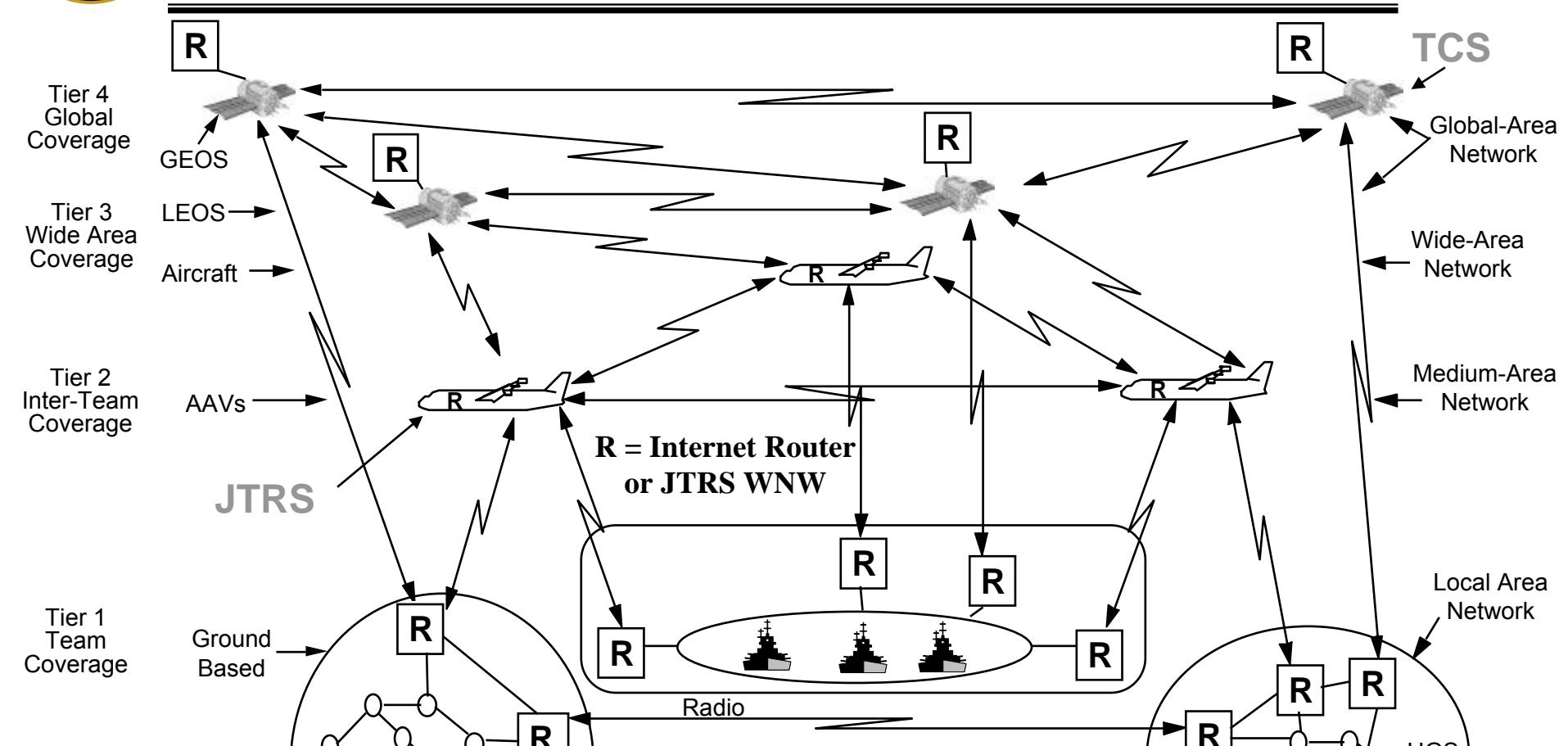
Network Centric Warfare

Tactical level of deployment and warfare

- Uncleared Personnel
- Links effects to targets
- Engages directly with the enemy
- Must be agile, adaptive and versatile
- Minimal, “portable” C4ISR infrastructure
 - Rides on tactical communications
 - Requires LPD/LPI transmission security
 - NCW weapons susceptible to IA attack



GIG: Transport Layer



How Is Communications Interoperability Facilitated Here?

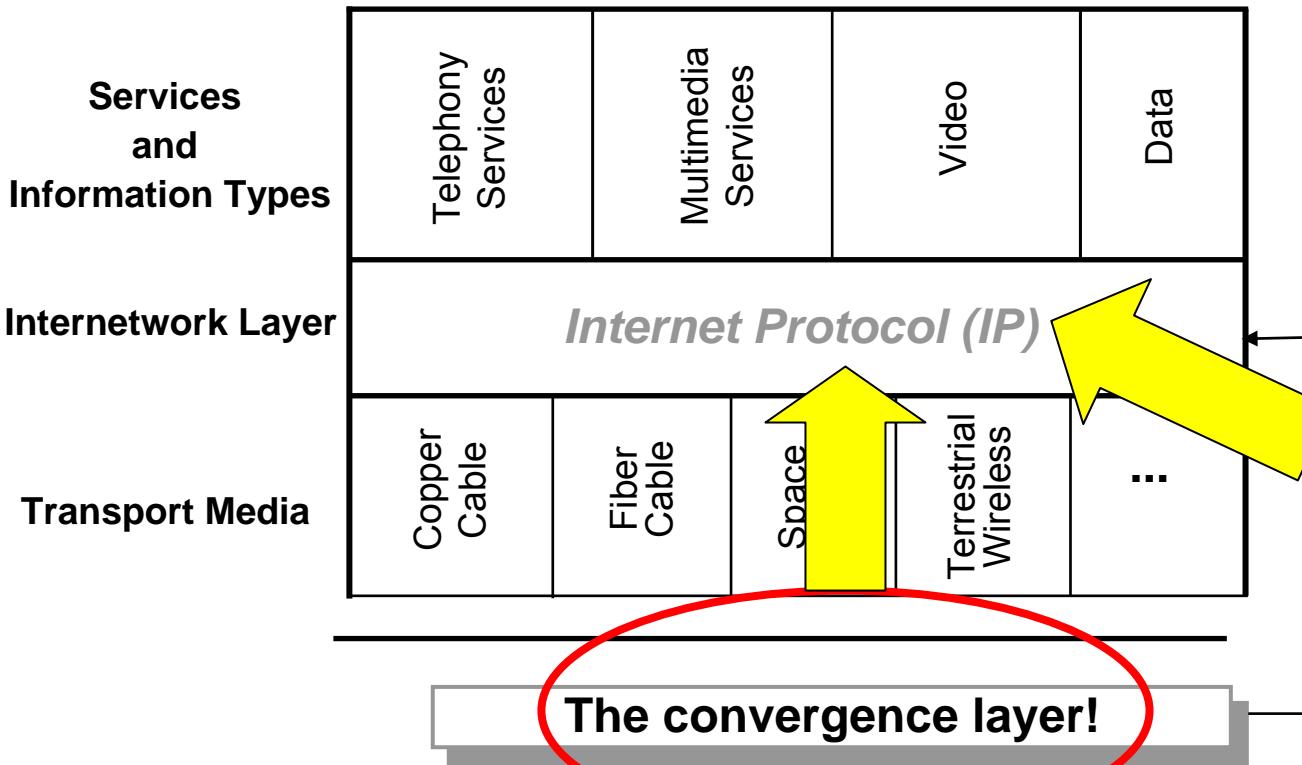
GIG-BE

Weapons Sensors

GIG-BE

Build The Net

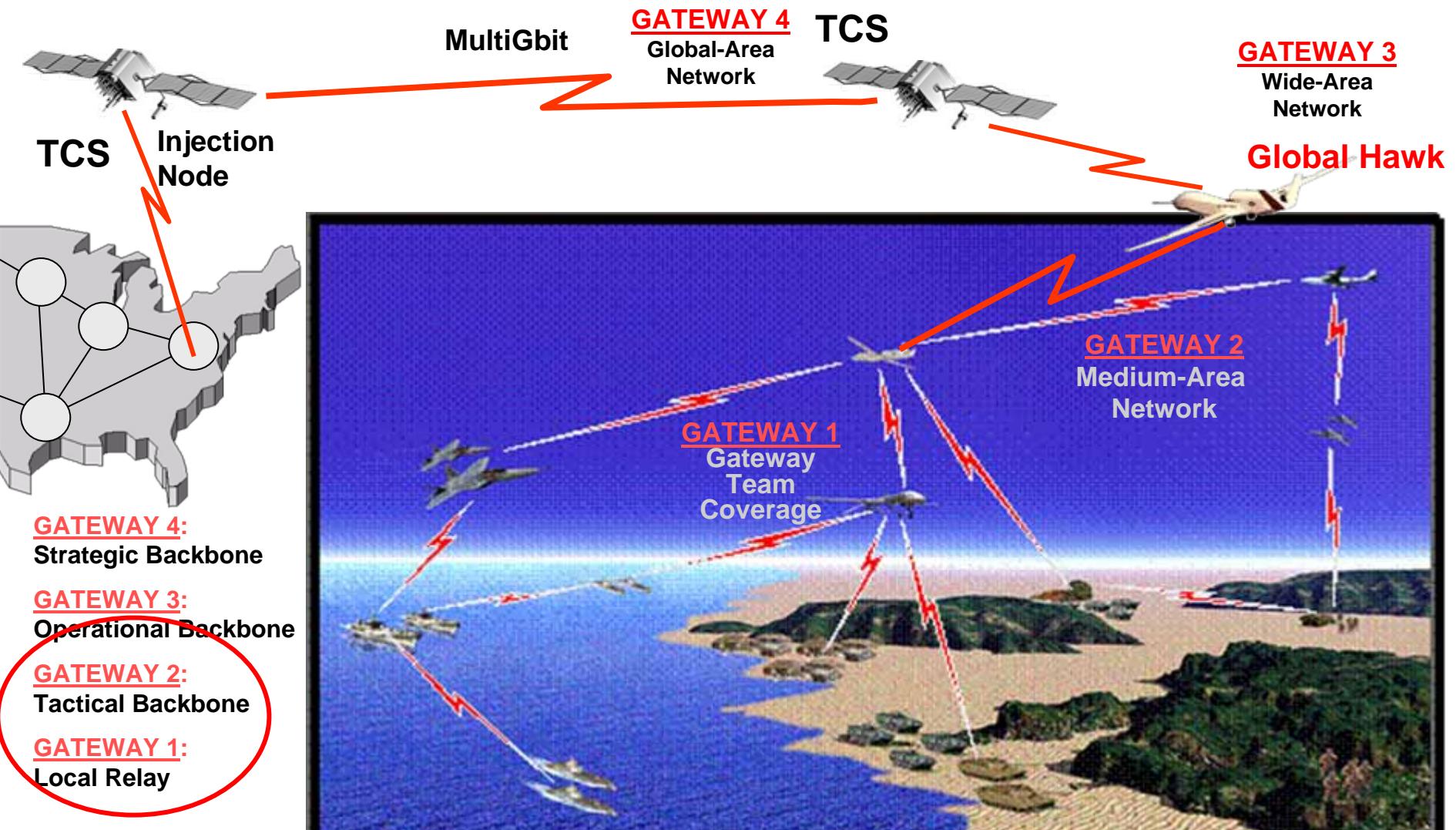
GIG: IP Based

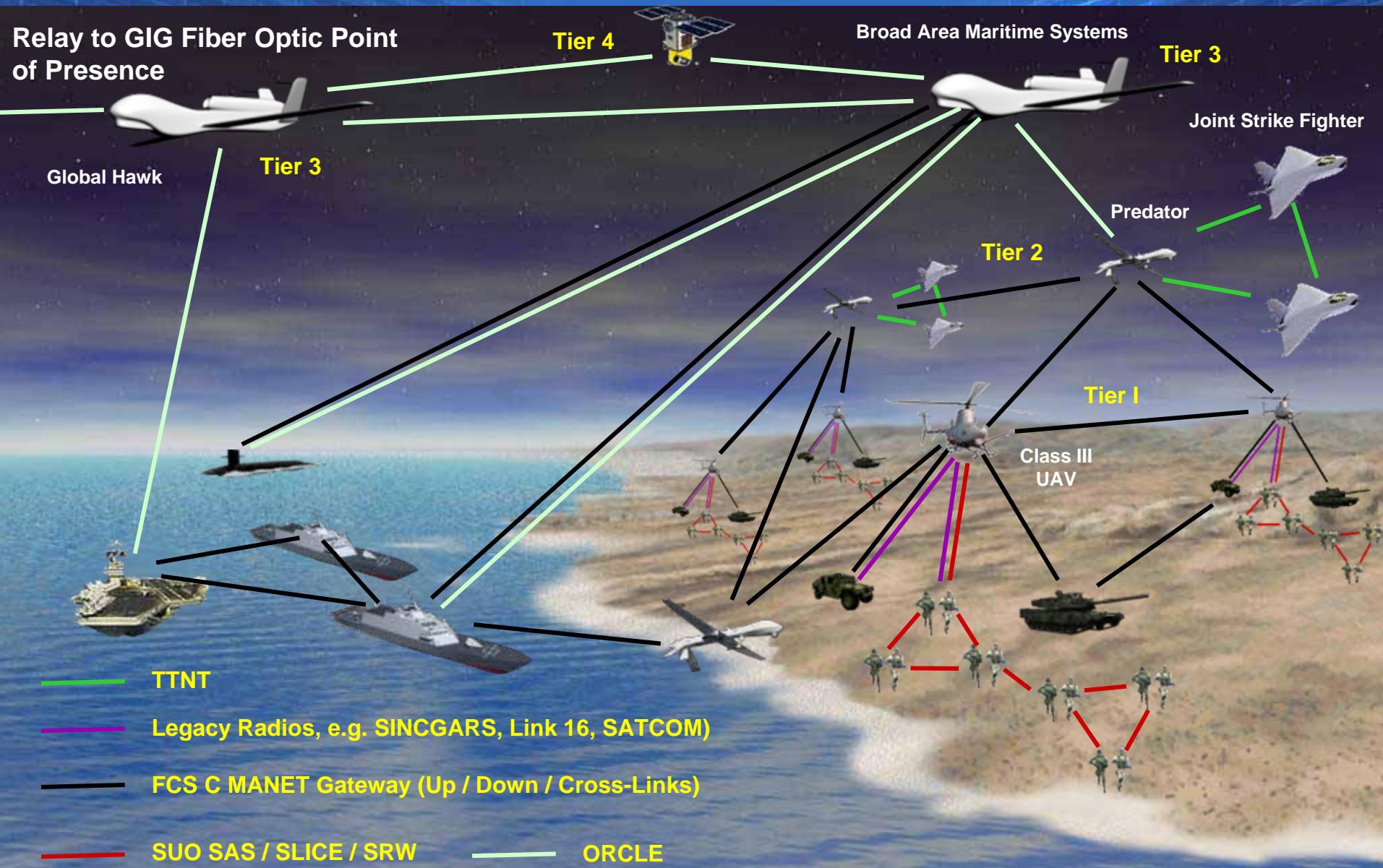


- *World-wide acceptance and use*
- *Packet-switched Internet transport*
- Provides *common-user, integrated services framework*
- Provides *standardized interface between Application and Transport Services*
- Used over many network-level protocols (Ethernet, ATM, WAP...)

Answer: Communications Interoperability via the Network!

How Do You Make This Happen: Network Gateways

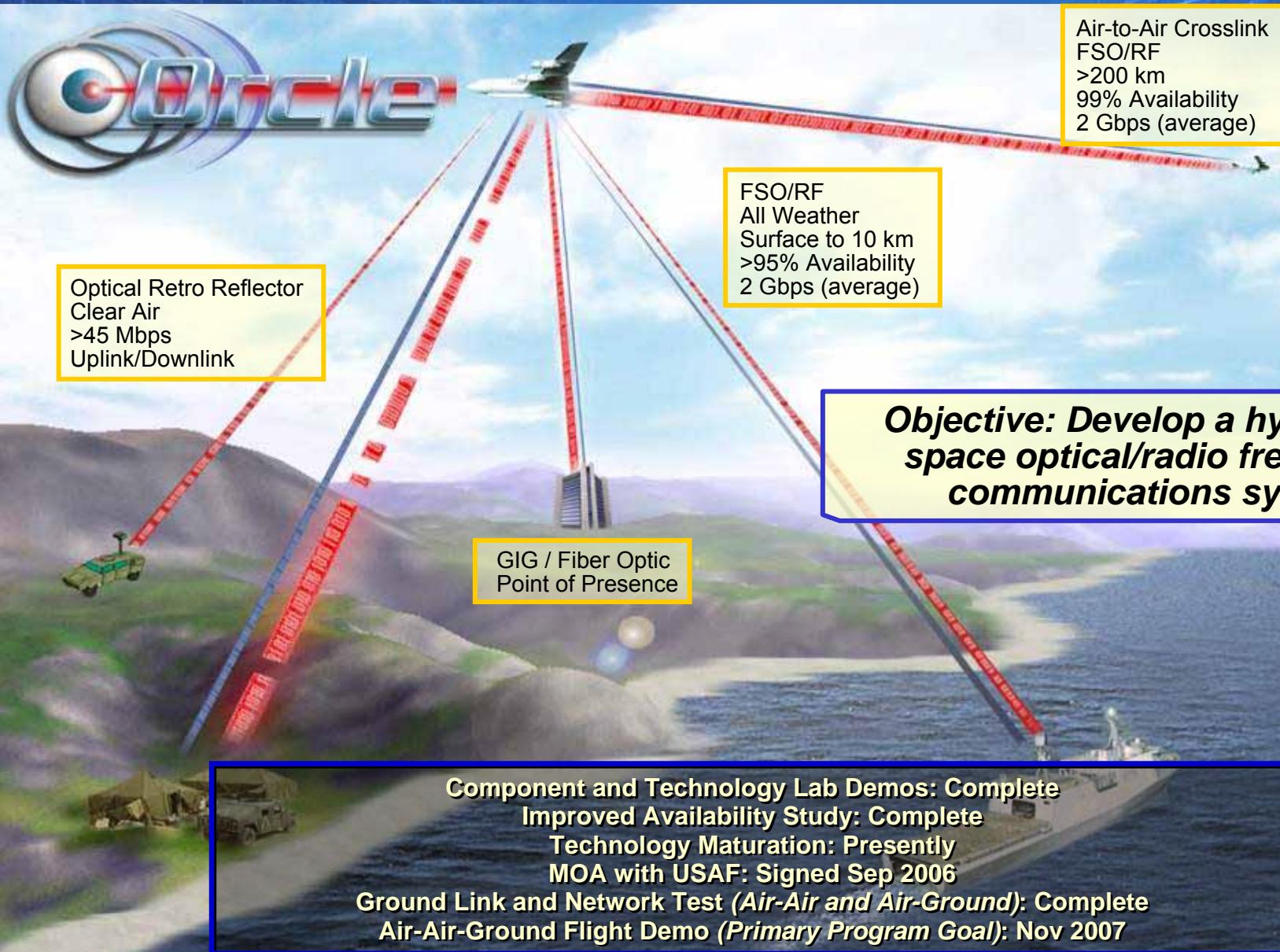






Optical & RF Combined Link Experiment (ORCLE)

Links to forces fixed and on the move



Future Combat Systems Communications

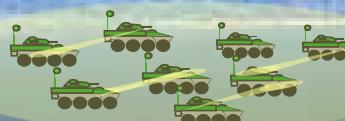
A Dual-Rate, Mobile Ad-Hoc Network for the Maneuver Force

Mobile ad-hoc network *dynamically* reconfigures during operations to *automatically* maintain network connectivity



QoS Provides for Adaptive Communications Capabilities

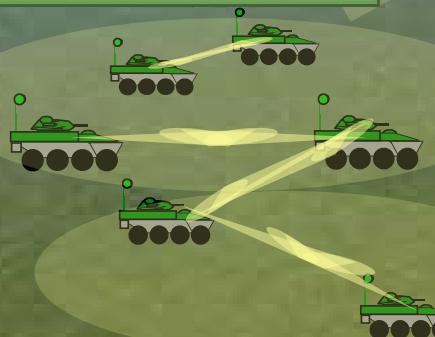
System automatically schedules non-interfering communications for increased network capacity



High Band (JTRS NDL-Like)
> 50 Mbps rate high band

Spatial re-use improves network capacity

Low Band (JTRS WNW-like)
> 5 Mbps rate low band



Networked vehicles automatically communicate when within range – no manual configuration

Multi-Mode Connectivity Options:
GND-to-GND, GND-to-AIR,
AIR-to-AIR &
AIR-to-GND

Network Centric Field Experiment at Fort Benning – JAN 2006



FCS Communications Technology Highlights



- **Assured high data rate communications:** Simultaneous high data rate networked communications in high and low bands. Adaptive data rates 72 Mbps in high band, 10 Mbps in low band. Spatial re-use through directional antennas for increased network throughput.
- **High resistance to threat jamming:** Directional antennas, supplemented by AV-OFDM waveform in low band and DSSSS in high band. Digital beam forming in low band steers nulls against jammers. Adaptive networking routes traffic around jammers.
- **High resistance to threat detectors and intercept:** Very narrow directional beams in high band; directional beams in low band, with featureless OFDM waveform.
- **Assured multi-path communications:** Low band AV-OFDM waveform integrates over frequency and time, outperforms rake receivers at low cost/weight.
- **QoS based ad-hoc mobile-mobile networking** incorporating the benefits of adaptive waveforms and smart antenna technology in both low and high bands for improved message throughput in threat and non-threat conditions.
- **Validated designs validated through relevant field demonstrations** air and ground mobile nodes including actual military robotic platforms, airborne nodes, surrogate netfires supplemented by critical laboratory modeling and simulation for validation and scalability.



FCS C Demo 3 Go/No-Go Results



| FCS Communications Go/No-Go Metrics | Demo 3 Criteria | | Raytheon (FCS-C) | |
|--|-------------------------------------|--|--|---|
| 20 Node Average Network Aggregate Throughput (Goodput) Low Band High Band | AJ/LPD 200 Kbps 1 Mbps | HDR 10 Mbps 70 Mbps | AJ/LPD 203 Kbps 24 Mbps | HDR 10.3 Mbps 50 Mbps |
| LPD/AJ Spatial - Low Band (3 dB beamwidth) Spatial - High Band (3 dB beamwidth) Processing (PG, nulling, etc.) Low Band High Band | 45° 3.5° x 12° * | 40 dB 14 dB * (19.4 dB) | 39° 3.5°x12° | 41.6 dB 19.4 dB |
| Latency Type 1 (10% of the avg sys load) Type 2 (30% of the avg sys load) Type 3 (60% of the avg sys load) (Retrans 3x) | | 90% < 200 msec. 90% < 1 sec. 90% < 30 sec. | 90.0% 88.8% 98.9% | |
| HB/LB Transition | | <1 sec. | 1 sec. | |
| Packet Delivery Type 1 (10% of the avg sys load) Type 2 (30% of the avg sys load) Type 3 (60% of the avg sys load) (Retrans 3x) | | 90% 90% 90% | 75.0% 73.6% 88.3% | |
| 20 Node Network Initialization Time | | <6 min. | 2 min. | |
| Node Entry Time | | <30 sec. | 10 sec. | |
| Detect Node Exit Time | | <10 sec. | 5 sec. | |

Live Test under operational conditions - User level performance

NOTE: Items in Red corrected upon return to lab and GO/NO GO validated in Raytheon Parking Lot



What Was Demonstrated by the FCS C NC Demo



1. Raytheon Network Centric Radio In Operations

- Operates Like WNW would in Network Centric Operations at Tier 1 & Tier 2
- SCA Compliant, Non-Proprietary Software
 - Raytheon Will supply FCS C Waveform Given to JTRS Library as above
- High data rate LOS (including LOS airborne extensions to BLOS) networked radio system
 - >100 km Non-LOS Ranges Achievable with Airborne Relays
 - Automatic Adaptation to Lower Data Rates for Increased Range
- Automated “configuration” and Network Management

2. Heterogeneous Gateway Architecture Implemented In TCA Structure

- Gateways linked end-users via Sample WAN technologies
 - FCS-NC, Ku SATCOM, Inmarsat, Iridium, GlobalStar
- Gateways linked end-users via Tactical Data Radios (IP Capable)
 - EPLRS, EPLRS micro-Lite, Soldier Radio Waveform (SRW), SECNET 11
- Gateways linked end-users via Tactical Voice Radios
 - PRC 117, PRC 119, PRC 150

3. Complete Soldier Operation In Simulated Missions

- Initial Training in NOV/DEC 2005 at Fayetteville, TN
- Heterogeneous Gateway Operations as well as Surrogate UAV Placement for Optimum Connectivity

Demonstrated Transformational Communications Down to the Platoon

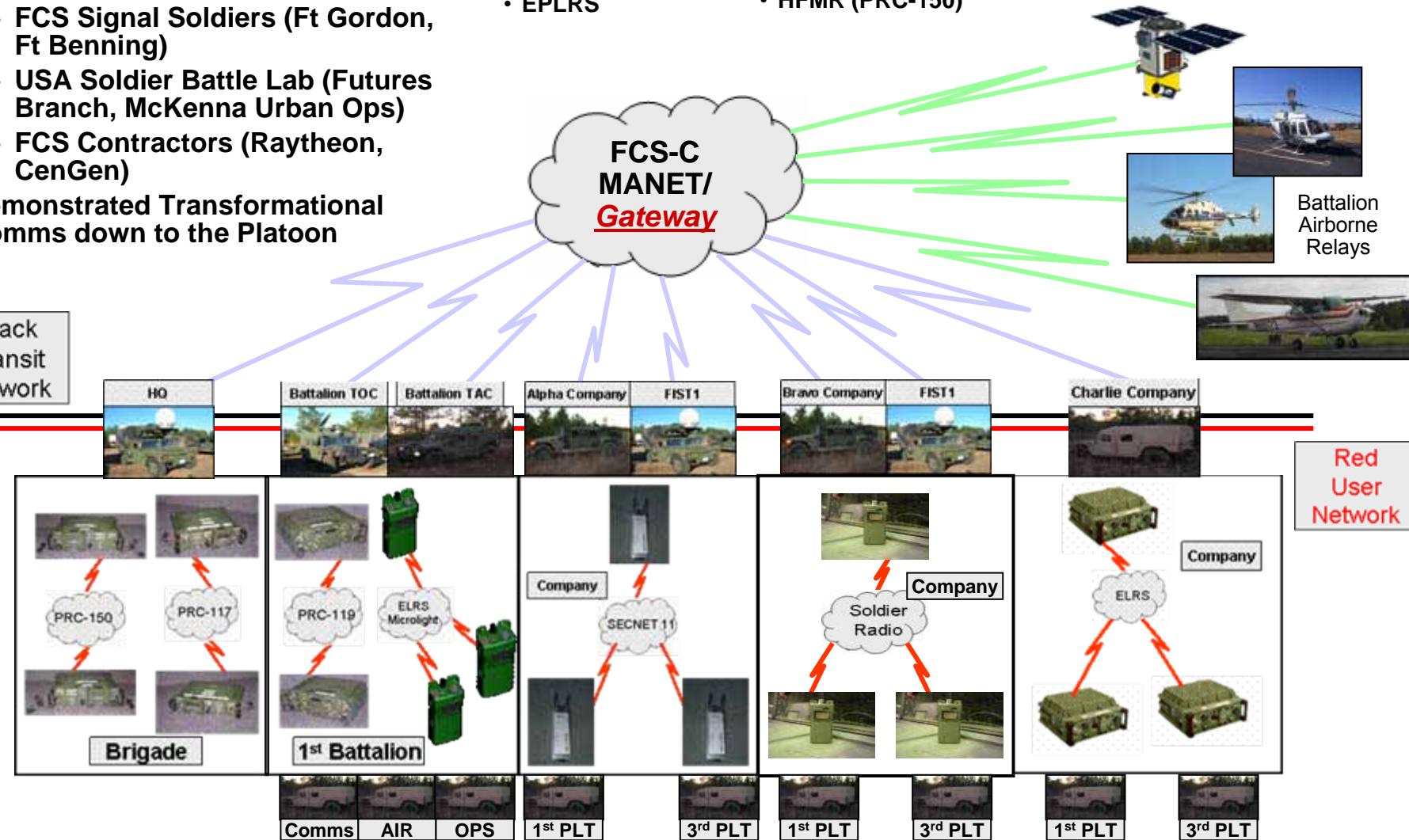
FCS-C Network Centricity Demonstration

Network Connectivity with FCS MANET & Gateway

- Network Centric Radio Operations
- Heterogeneous Gateway Architecture
- Complete Soldier Operation
 - FCS Signal Soldiers (Ft Gordon, Ft Benning)
 - USA Soldier Battle Lab (Futures Branch, McKenna Urban Ops)
 - FCS Contractors (Raytheon, CenGen)
- Demonstrated Transformational Comms down to the Platoon

Interoperable Communications

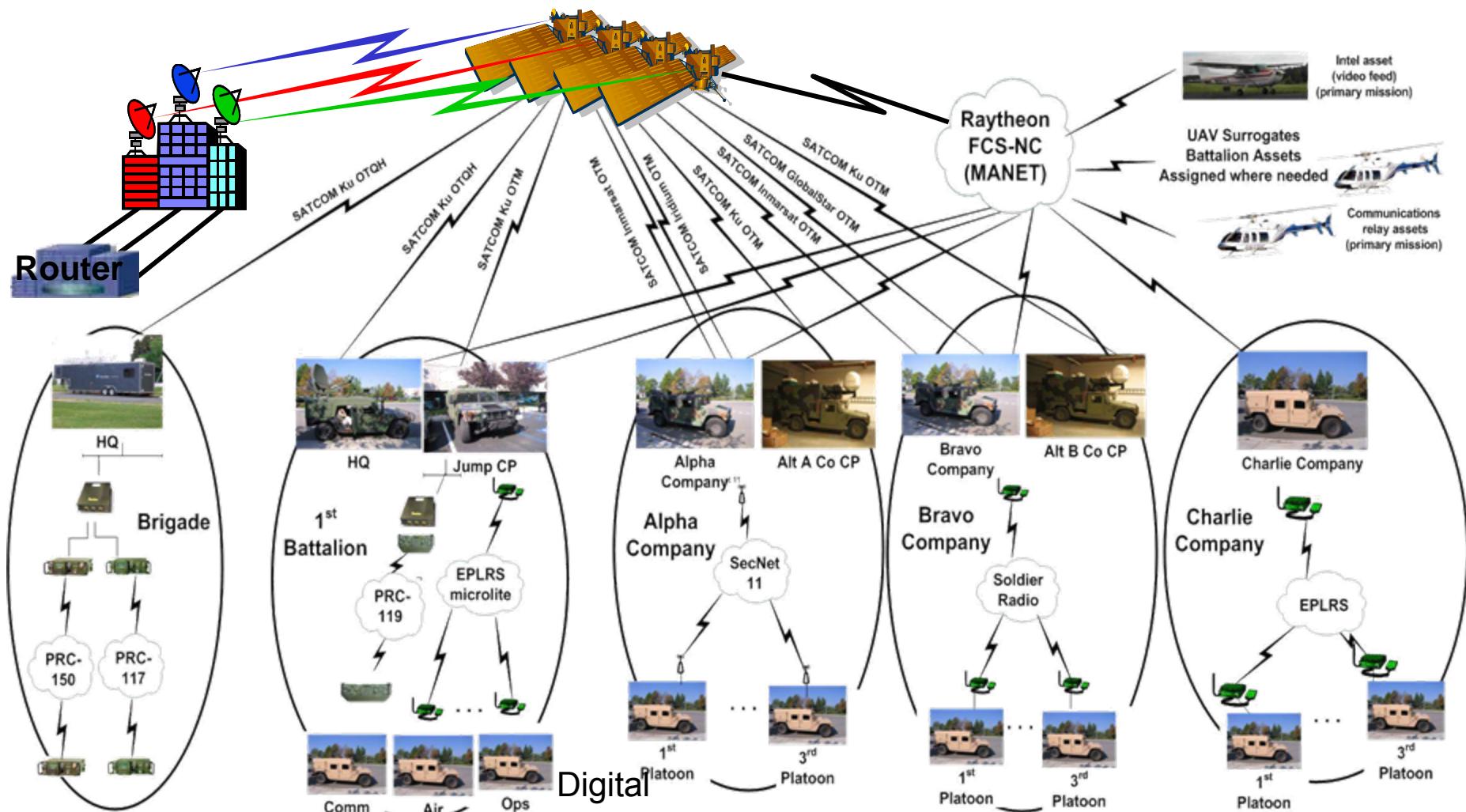
- CPOF's VoIP
- ITT Soldier Radio
- EPLRS
- HAVEQUICK I/II (PRC-117)
- SINCGARS (PRC-119)
- HFMR (PRC-150)





Heterogeneous Network Centric Architecture

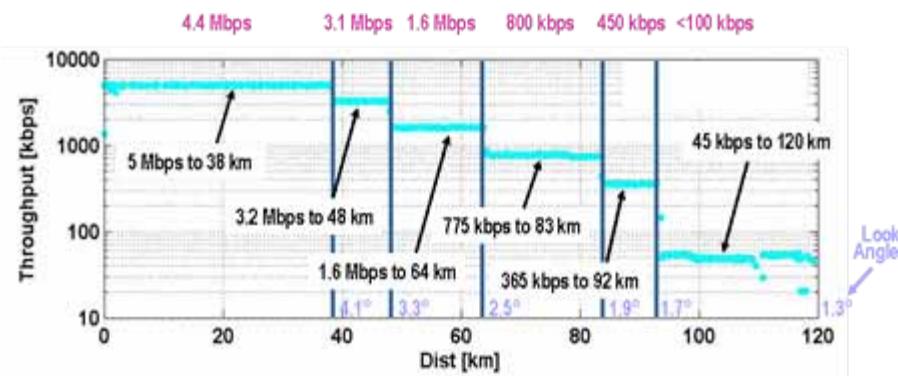
FCS-C NC Demonstration



- **Heterogeneity between Radios and Radio-Types (Analog Voice vs Data/VoIP)**
 - Translate everything into IP (Analog Voice to VoIP)
 - Interoperate at the Network Layer (OSPF)
 - Demonstrated over 120 km-wide scenarios

| Characteristic | Wideband Network Waveform | FCS C MANET / Gateway ² |
|--|---|---|
| Demonstrated Max Data Rate at Max line-of-sight, point-to-point mode | <ul style="list-style-type: none"> 1 Mb/s @ ~14 miles (Expansion to 2 Mb/s is planned for summer of 2008)¹ | <ul style="list-style-type: none"> 5.5 Mb/s @ 23.6 miles 1.6 Mb/s @ 39 miles 775 Kb @ 51.6 miles |
| Demonstrated Radio Interoperability with Networking | <ul style="list-style-type: none"> Demonstrated hardware running WNW simultaneously with a JTRS version of a legacy signal, which proves the feasibility of key JTRS concepts, waveform portability and simultaneous waveform operation ¹ | <ul style="list-style-type: none"> Simultaneous demo at Ft Benning of MANET/Gateway communications among the following digital and analog systems: CPoF's VoIP, the ITT Soldier Radio, the Enhanced Position Location Reporting Systems (EPLRS), HAVEQUICK I/II (PRC-117), the Single Channel Ground and Airborne Radio System (SINCGARS/PRC-119) and the High Frequency MAN-PACK Radio (HFMR/PRC-150) and various SATCOM Links. |

Demonstrated FCS C Performance at Ft Benning



Note: The Army's Joint Network Node was not included in this comparison as JNN is not a tactical MANET system as JTRS WWW and FCS C. It is on-the-halt (Static) SATCOM (non-MANET) and is designed to be integrated into tactical backbone at Brigade fixed TOCs.

¹ Charlotte Adams, "Editor's Note: Reinventing JTRS", *Avionics Magazine Monthly News*, Volume 1 Issue 1, July 17, 2006.

² FCS C Network Centric Demonstration, McKenna MOUT Site, Ft Benning, January 2006

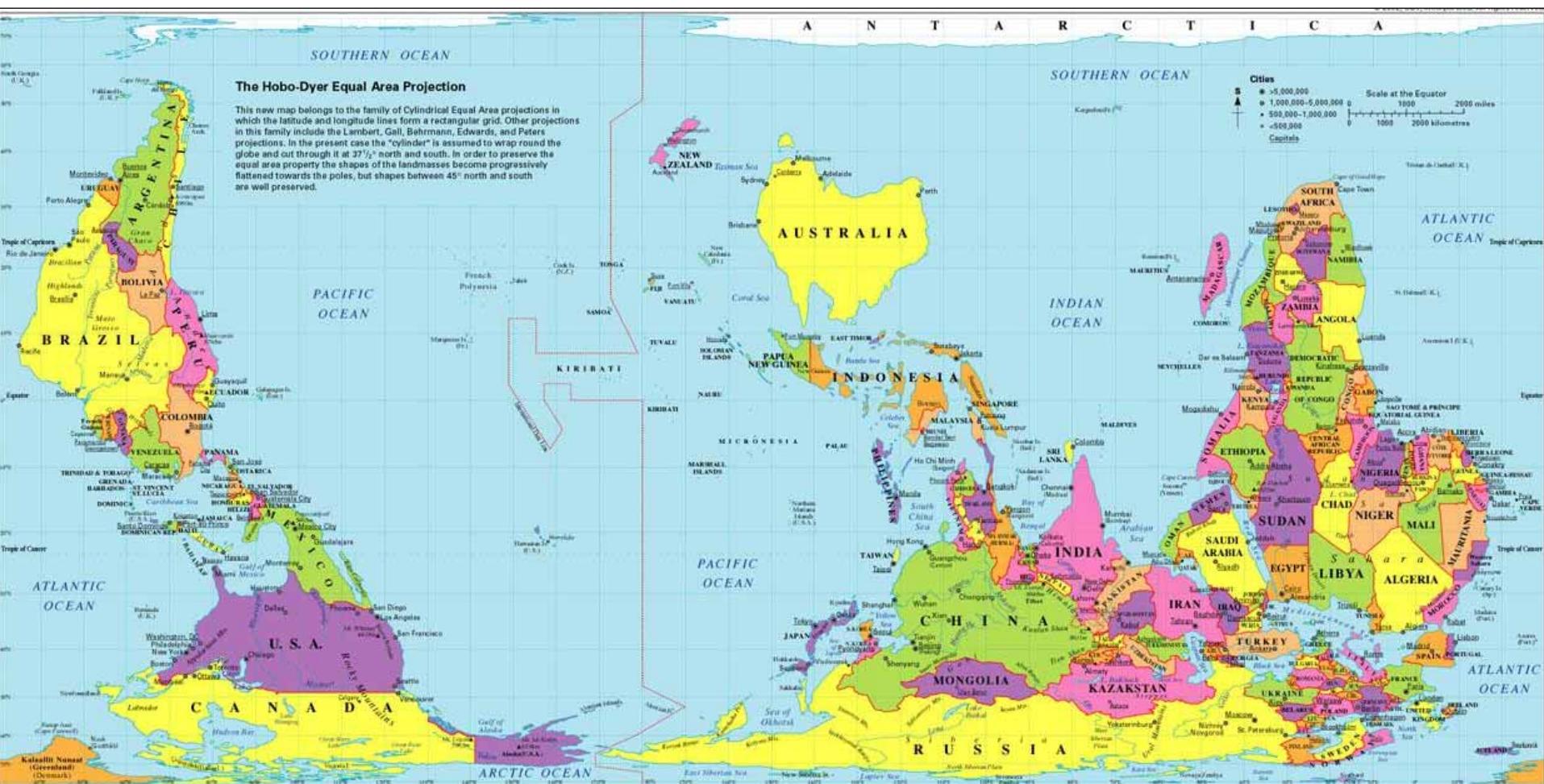




Current Theatre Environment An Australian Perspective

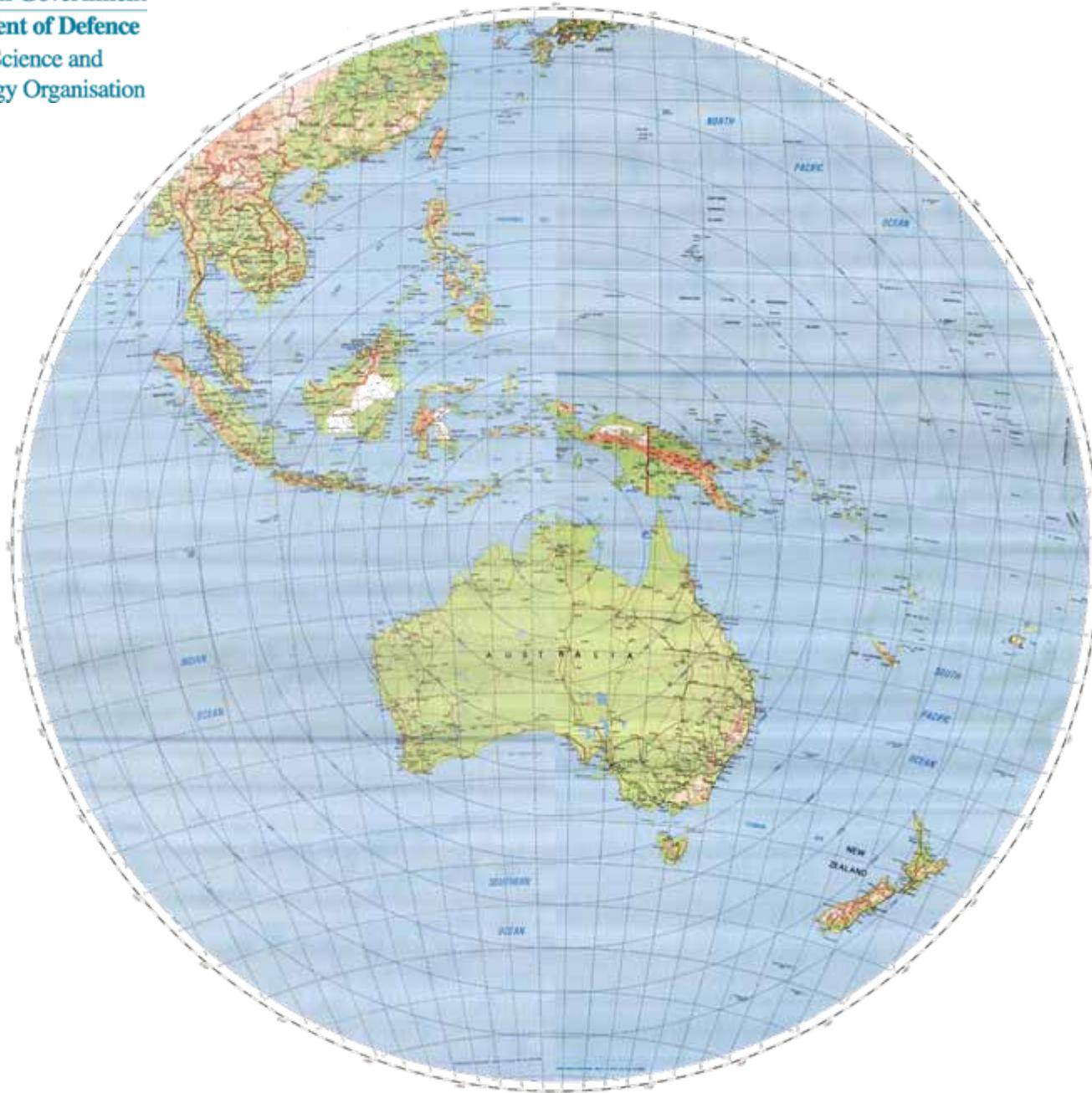
Dr Roger Lough
Chief Defence Scientist

Pacific Theatre Operational Science and
Technology Conference
Hawaii
April 2007





Australian Government
Department of Defence
Defence Science and
Technology Organisation



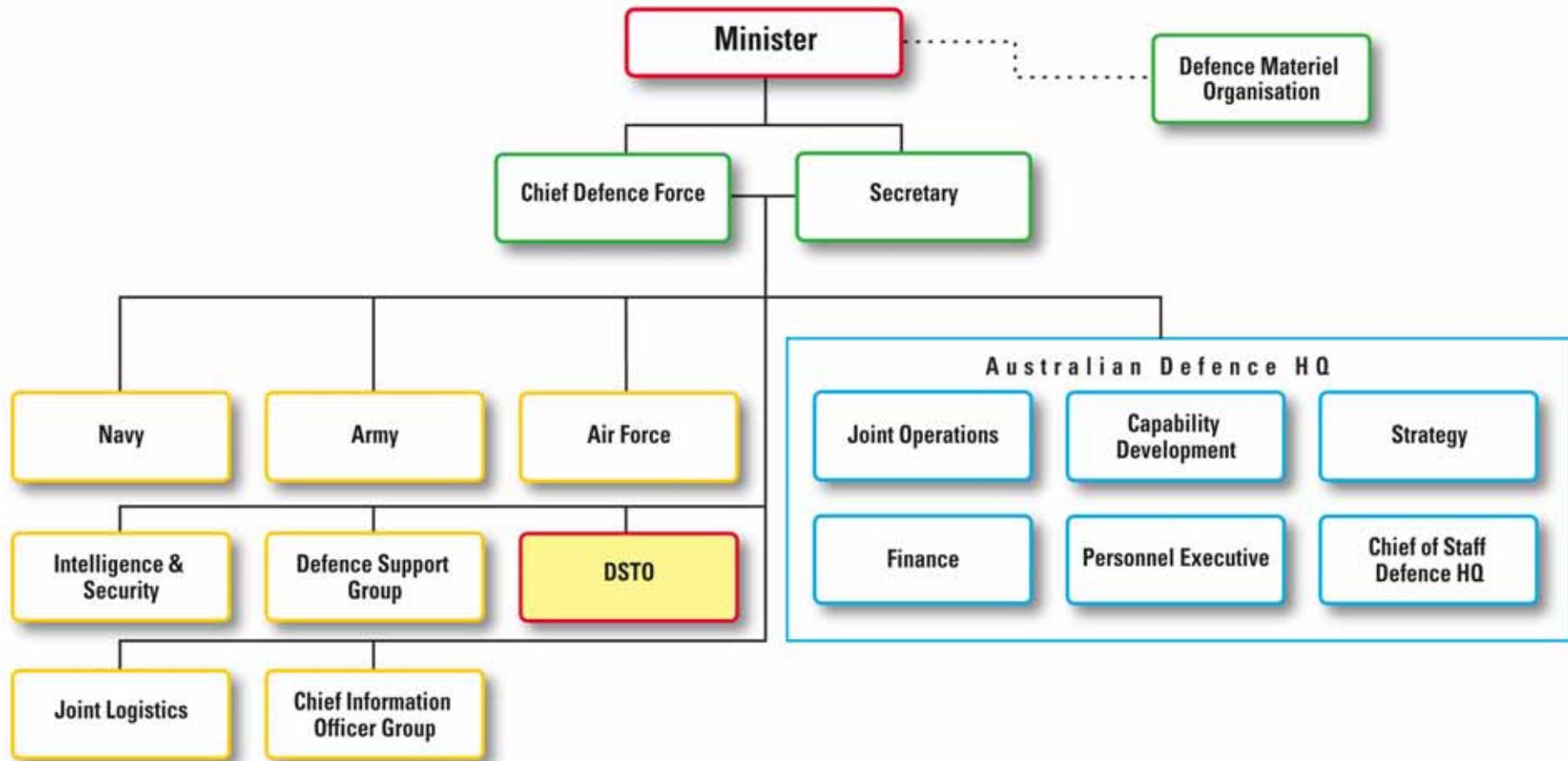


Australian Government
Department of Defence
Defence Science and
Technology Organisation

DSTO Mission and Vision



Defence Structure





DSTO at a Glance





DSTO Functions

Policy

**Operations &
sustainment**

**Capability
development**

**Industry
capability**

**Technology
base**



Program Thrusts

Wide Area Surveillance





Program Thrusts

Network Centric Warfare





Program Thrusts

Interoperability



Joint Australian United States
Exercise – Talisman Sabre 07



Coalition Readiness Management
System Project Arrangement -
CReaMS

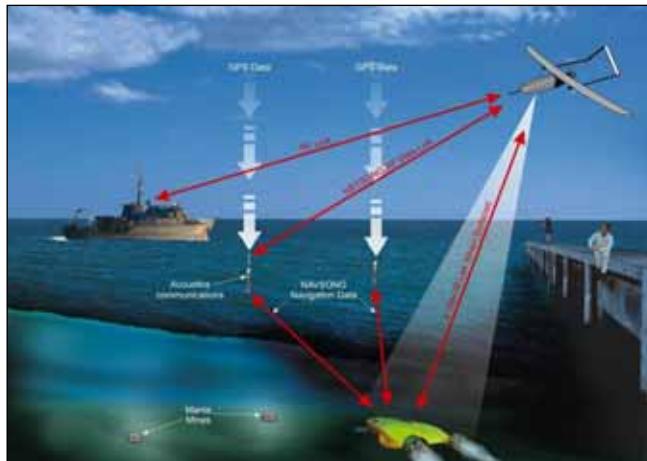


Program Thrusts

Experimentation

Automation of the Battle
Space Initiative

Headmark



Headline – Concept Exploration and
Analysis Laboratory (CEAL)



Program Thrusts

Chemical, Biological & Radiological Defence



PC3 Laboratory



Breathable Chemical and
Biological suit



Program Thrusts

Aging Aircraft



Structural test on F/A-18

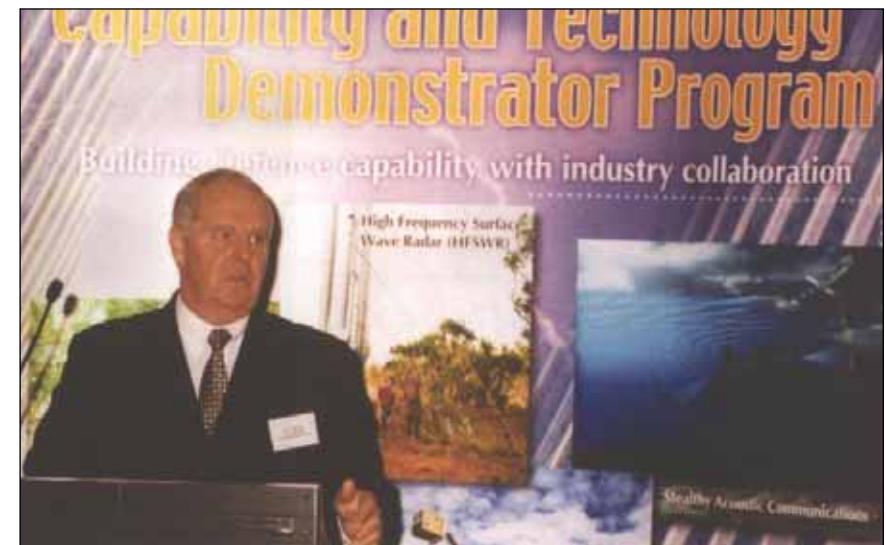


Smart Structures



Capability & Technology Demonstrators

- Allows Australian Defence Industry to demonstrate how advanced technology can enhance Defence capability.
- \$160 M invested since 1998.
- Average CTD \$3m; 3 years.





Capability & Technology Demonstrators



Underwater Personal Computer



Fibre Laser Sonar
(Hydrophone)



Capability & Technology Demonstrators



Cuttlefish – protection of ships
from radar surveillance

Rassputin Sonobuoy



Emerging Issues



Operational
Tempo



IEDs



Space
(Hypersonics)



Intelligence, Surveillance and
Reconnaissance



Australian Government
Department of Defence
Defence Science and
Technology Organisation

Thank you



Perspective on S&T Collaboration



**Tae-In Choi, Vice President
Agency for Defense Development**

Operational S&T Conference

PACOM, Hawaii

April 2007

Overview of Talk

- ◆ RoK Battle Lab Status
- ◆ RoK/US S&T Cooperation
 - Examples of Joint Development
- ◆ Conclusion

Naval Battle Lab.

Under New SBA System

- The Role of Battle Lab.
- ROKN BL and ADD BL for SBA
- 2007 US-ROK NBE Symposium

The Role of Battle Lab. (1/3)



What is Battle Lab?

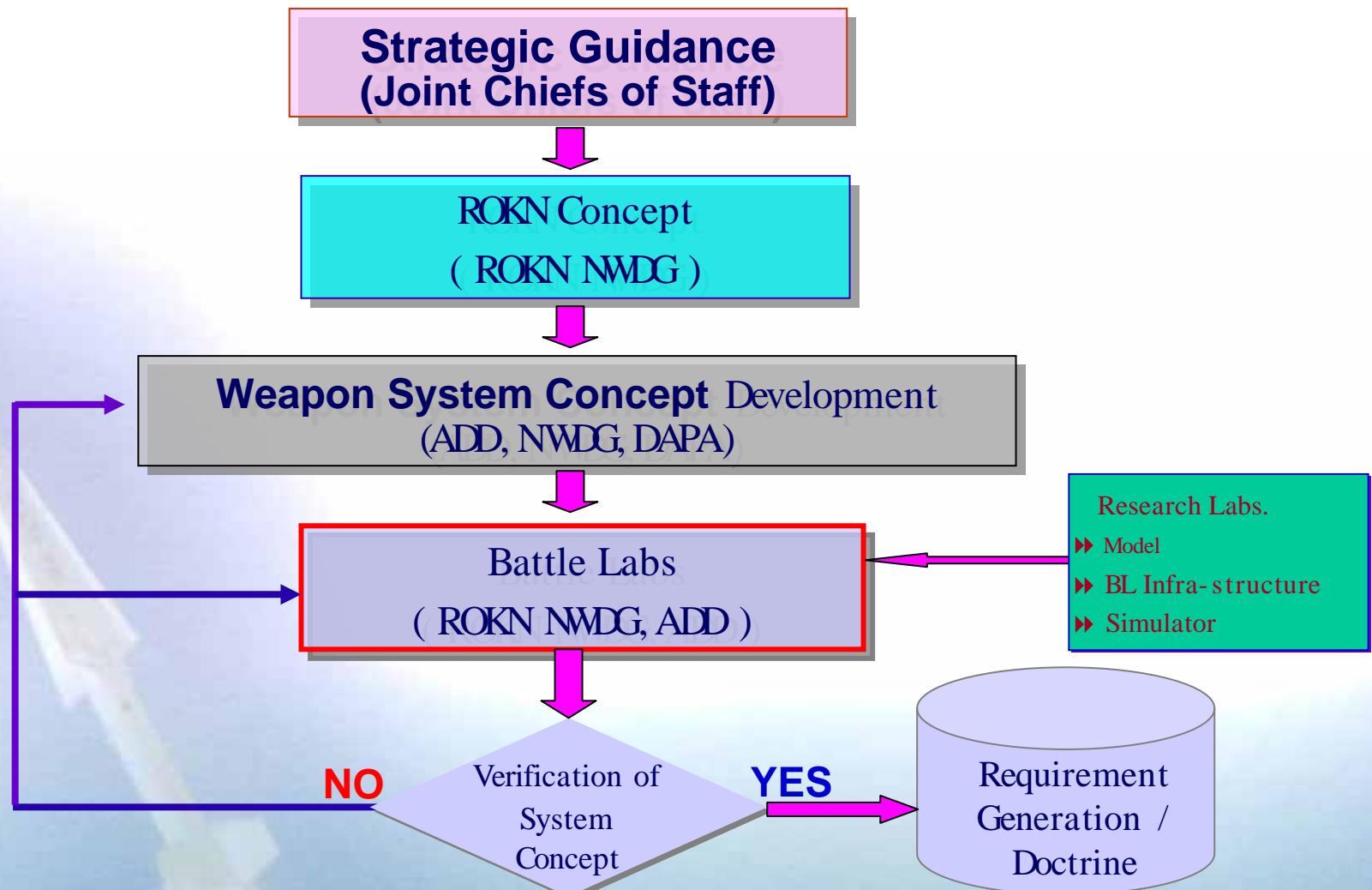
- A mechanism for assessing New Ideas & Capabilities provided by advanced technologies
- An innovative mechanism for scientific requirement generation based on the operation concepts of future battlefield
- A core verification tool in Top-down/Born-Joint weapon development flow
- Battle Lab needs to be designed to meet diverse requirements as engineering test beds for R&D Program Managers and as simulation tools for field commanders, tactical planners, and war gamers.



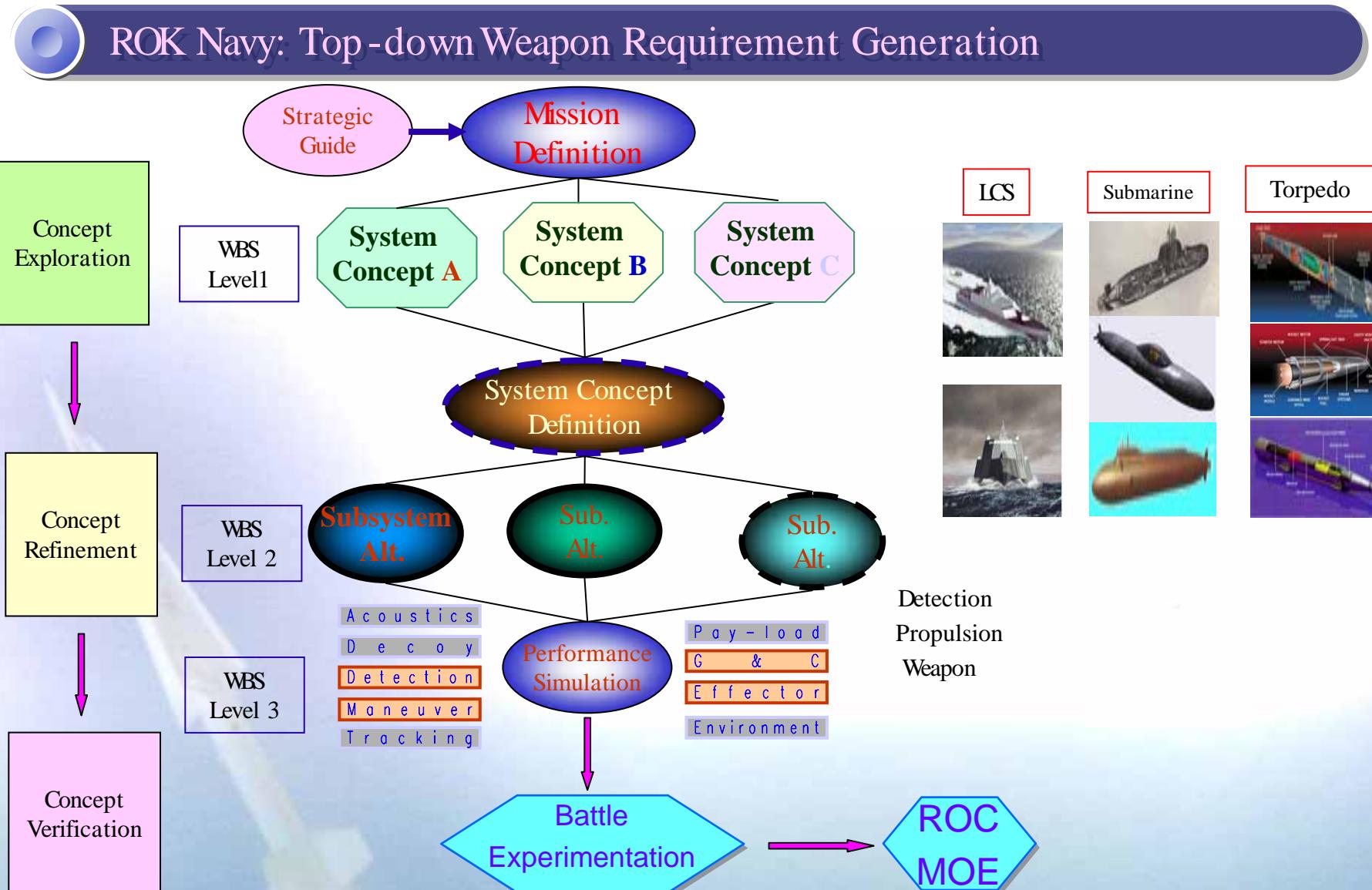
The Role of Battle Lab. (2/3)



ROKN New Weapon System Development Flow

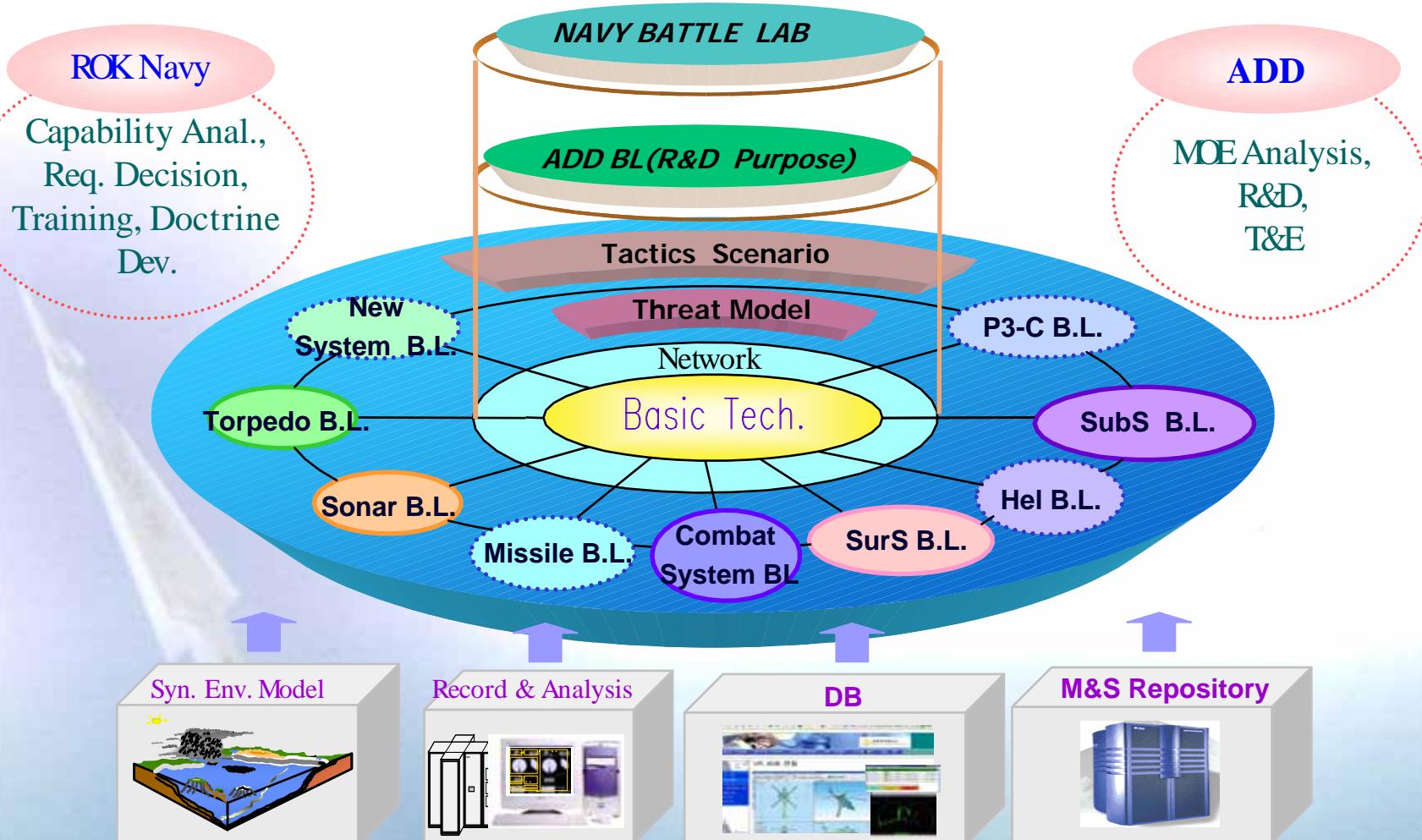


The Role of Battle Lab. (3/3)



ROKN BL and ADDBL for SBA (1/3)

Simulator-based ADD BL and ROKN BL Building



ROKN BL and ADDBL for SBA (2/3)

ADD Battle Lab Development Center based on LBTS



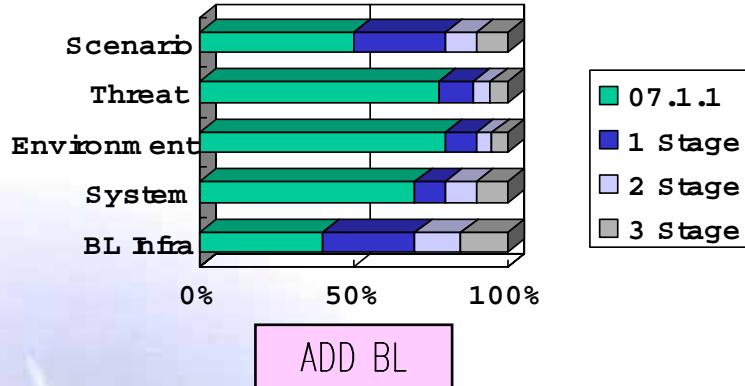
LBTS : Land Based Test (Training) Site (System)



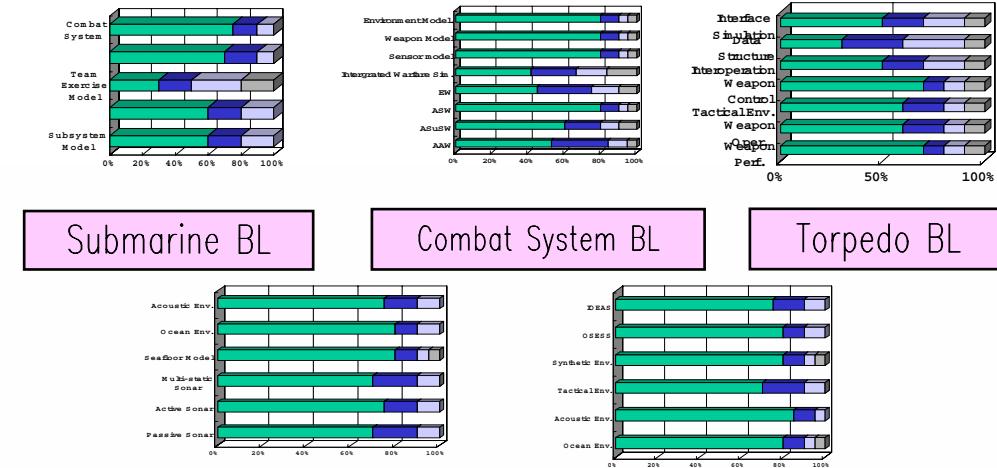
Status and Roadmap for ROKN BL and ADD BL (3/3)



ADD BL Status



Weapon System BL Status

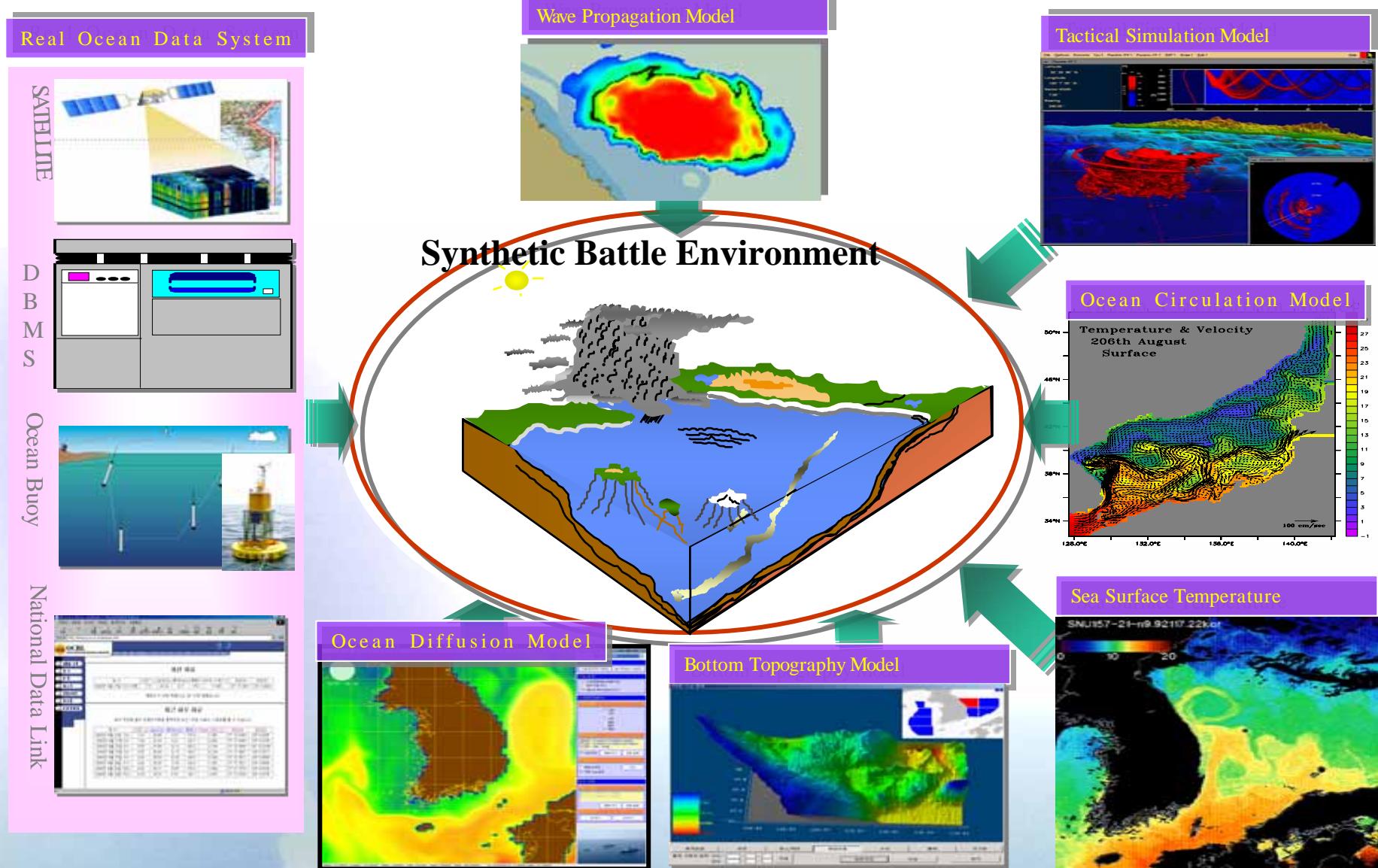


Roadmap of Battle Lab Development

| Year | 2006 ~ 2008 | 2009 ~ 2011 | 2012 ~ 2014 |
|-------|---|--------------------------------------|---|
| Stage | Infra Build-up | NBL BL Development | LVC based BL Development |
| ROKN | Mission Model ROKNWargame for Analysis Battle Exp. for Future Program | ROKN Wargame PIP ROKN BL Build-up | LVC based ROKN BL |
| ADD | Weapon System B.L. ADD BL R. G. | Battle Lab Development Center | Battle Lab Dev. Center PIP LVC based ADD BL Build-up |



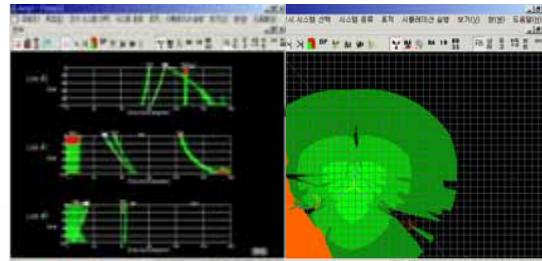
Synthetic Battle Environment Model



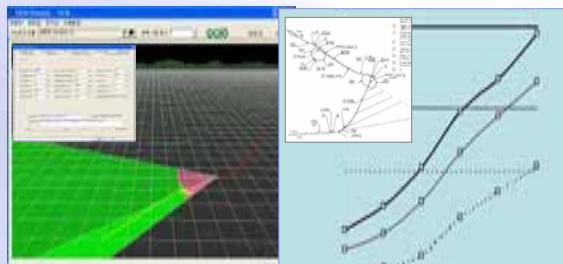
Detection System BL



M&S Resources for Underwater Detection System BL

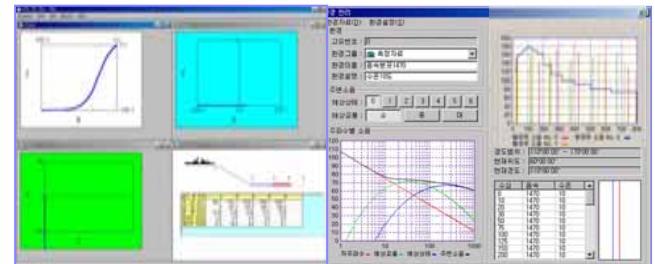


Detection Effectiveness Analysis for Harbor Underwater Surveillance System

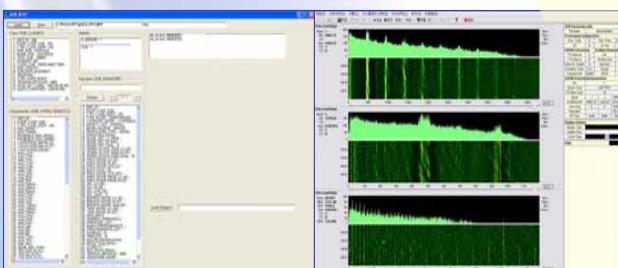


Operational Effectiveness Analysis for Torpedo Acoustic Countermeasure System

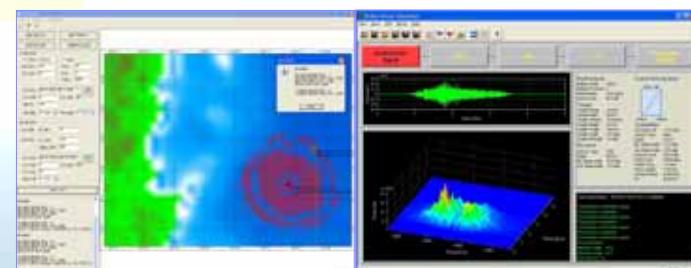
M&S Resources
for
DSBL-ADD



Detection Performance Analysis for Towed Line Array Sonar System



Signal Classification Algorithm Analysis for Navy Acoustic Information Management System



Detection Probability Estimation for Hull Mounted Sonar System

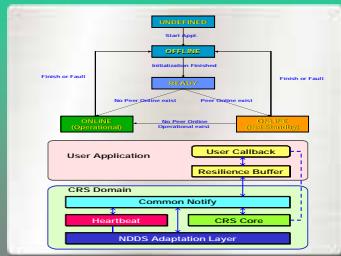


Naval Combat System BL

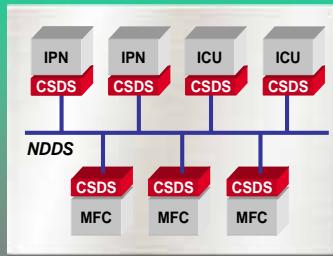


Combat System BL Status

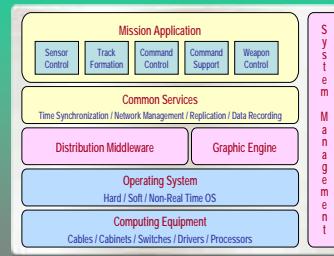
System Monitoring/ Analysis Model



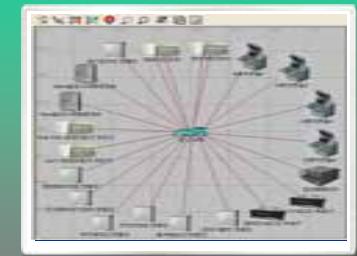
Common Infra (Middleware) Model



System Software Architecture Model



Network Architecture Model

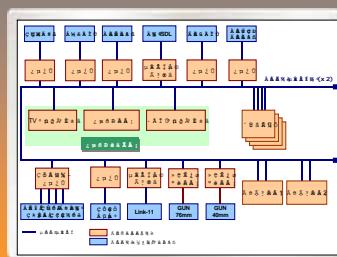


SYSTEM INFRA STRUCTURE MODELING & ANALYSIS

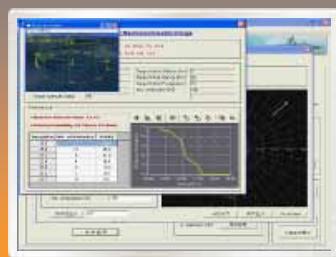
COMBAT SYSTEM LAND BASED TEST SYSTEM (Current Project, LPX & PKX)



SYSTEM & TACTICAL WARFARE PERFORMANCE
MODELING & ANALYSIS



System Construction
Model



Sensor System Model



Self Defense Model



Naval Gunfire Control
Model



2007 US-ROK NBE Symposium

- Date: October 25-26, 2007
- Place: JINHAE NAVY CLUB
- Objective of Symposium
 - Technical Information Exchange regarding Battle Lab. & Naval Battle Experimentation
 - Cooperative relation build-up between BL-related organizations of US & ROK
- Major Topics
 - Requirement Generation via Battle Experimentation for Naval Weapon Systems
 - SBA Strategy for US & ROK Naval Systems.
 - Synthetic Ocean Environment Modeling for NBE
 - Threat Modeling for Air/Surface/Undersea Warfare
 - Methodology for Fleet Battle Experimentation
 - Design and Analysis of Naval Battle Experimentation

Naval Battle Experimentation Workshop



* NBE: Naval Battle Experimentation



RoK/US S&T Cooperation



Evolution of Strategic Alliance

Dependency on Conventional Forces



Combination of US and ROK technologies enabled ROK self reliant defense



Deterrence on the Korean Peninsula and within the Asian Pacific Region



Defense/Economic/democratic growth



Enabling U.S. Strategic Flexibility – 3rd largest in OIF



Direct Support

Less Soldiers/FMS



Cooperate Self-reliant Defense

Cooperation



Cooperation in Defense R&D

Some examples of mutually beneficial exchanges include:

- Engineer and Scientist Exchange Program (ESEP)
- Data Exchange Agreements (DEA)
- Project Agreements (PA)
- S&T co-development: LOGIR
- Look forward to participating in PACOM's JCTD
 - : Medusa, AWSS

- * Medusa: JCTD version of LOGIR
- * AWSS=Airborne Weapons Surveillance System.

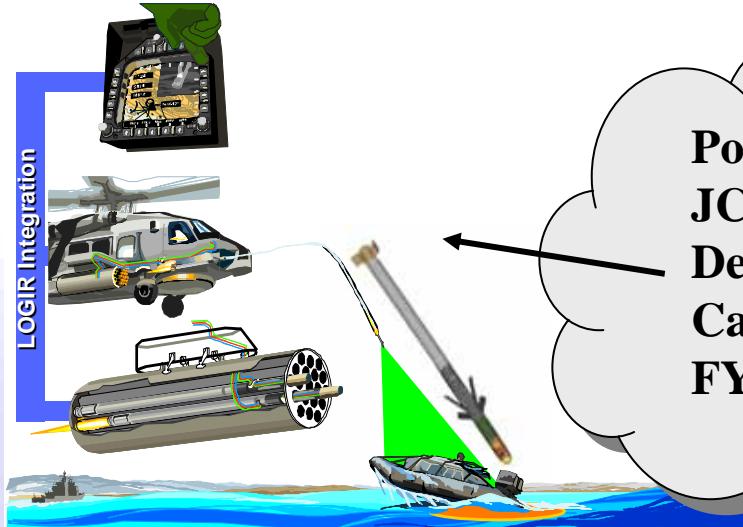
Technology Cooperation Sub-Committee (TCSC)

An-Heung PG/Feb. 2007



Ongoing/Upcoming Joint Efforts

LOGIR



Potential
JCTD
Developments
Candidates for
FY 08-10

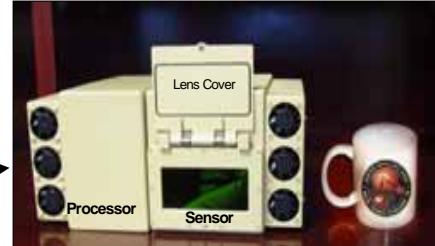
NAVAIR



FOR OFFICIAL USE ONLY

Miniaturized Processor

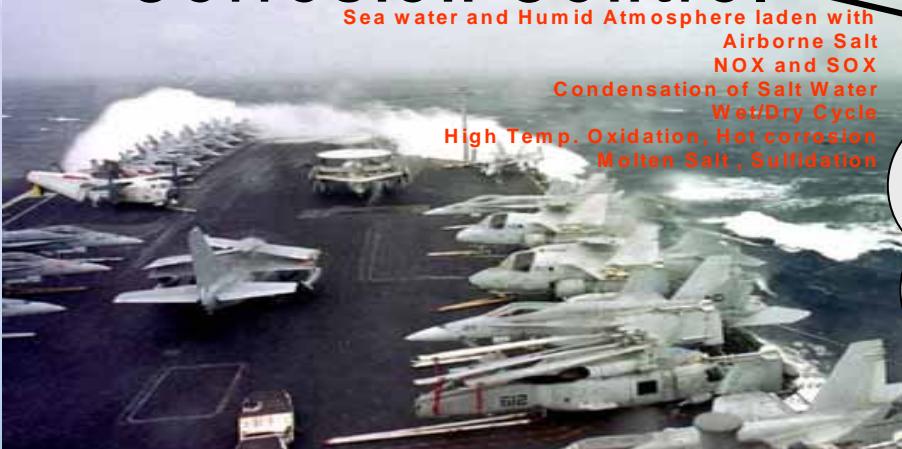
AWSS



Form Fit & Function

Corrosion Control

Sea water and Humid Atmosphere laden with
Airborne Salt
NOX and SOX
Condensation of Salt Water
Wet/Dry Cycle
High Temp. Oxidation, Hot corrosion
Molten Salt , Sulfidation

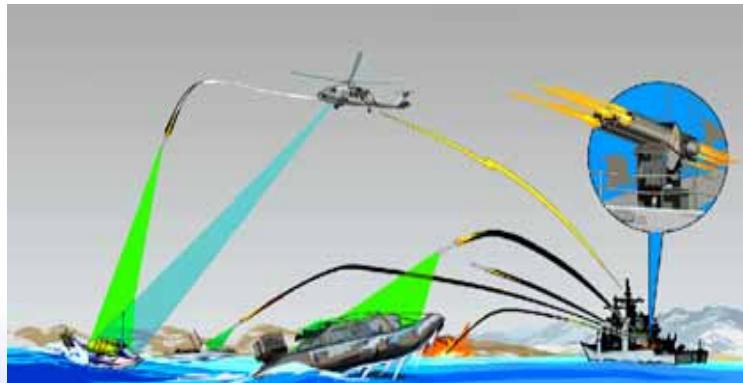


Cooperative
Program US
Government/
ROK Industry
with anticipated
Savings to US in
\$ Billions

IC108040137b 9



LOGIR Collaboration



Operation Concept

Warhead/ Fuze (Korea)

- M151 baseline (US)
- Plans improved performance given guidance section in front (Korea)



Tail Assembly Improvements (Korea)

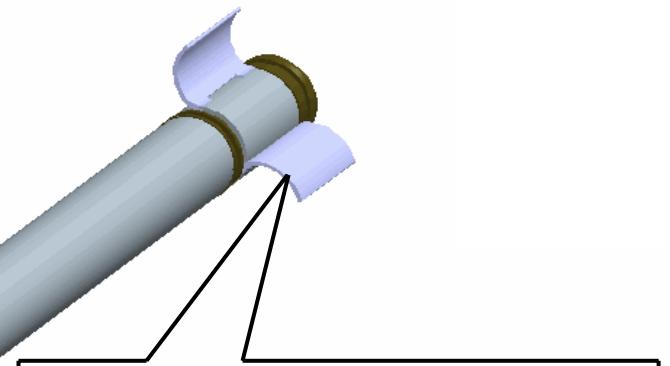
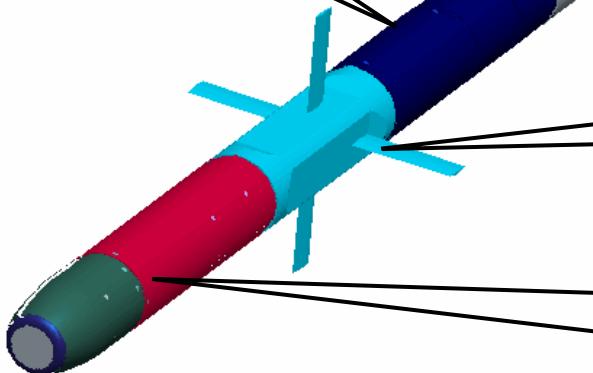
- MK 66 Mod 4 baseline (US)
- Plans improved aerodynamics & stability characteristics (Korea)
- *Part of an overall Korean initiative to improve performance through aerodynamic improvements to tail, seeker, and CAS*

Control Actuation System (US/ Korea)

- LOGIR demonstration design baseline (US)
- Design to cost to maintain required performance at a reduced cost (Korea)

Seeker/ Guidance & Control (US/ Korea)

- LOGIR demonstration design baseline (US)
- Improvements in electronic assembly design to reduce overall cost (Korea)
- Aerodynamic improvements (Korea)



LOGIR Status

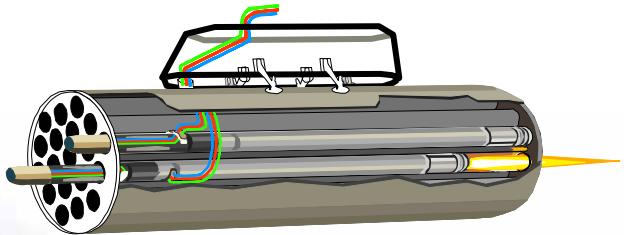
► LOGIR

- Currently S&T MOU for '07 ~ '09 between ADD and NAWC/China Lake
- To complement LOGIR technology in the areas of aero, structure, G&C, actuator, signal processing, and fuze.
- Unique Opportunities for T&E:
 - IR Data on Korea's Harsh Terrain/Weather
- Hope to continue on with SDD

► JCTD: Medusa

- April 4 workshop for details

Medusa JCTD



DRL



LOGIR

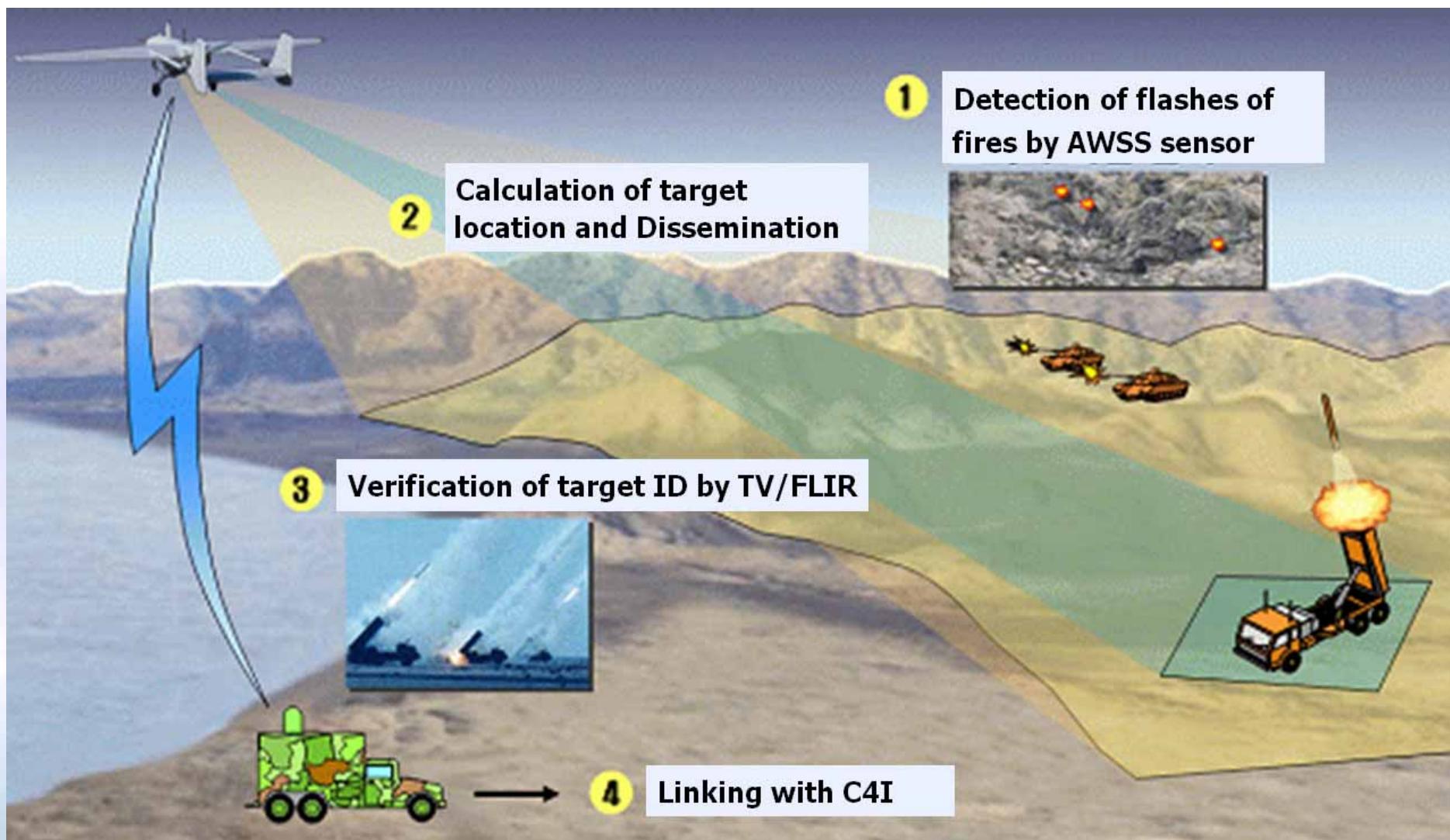


MH-60R



KO-1

- Develop core capability of LOGIR/DRL for MH-60R and KO-1 to address FAC/FIAC scenarios
- Demonstrate capability of LOGIR-enhanced platforms to engage and destroy multiple moving maritime targets



Airborne Weapon Surveillance System (AWSS)

- ◆ Offers target locations and classification information in near real-time by detecting, classifying, and locating flashes from target NK fires
- ◆ To combine AWSS sensor with UAV System (Falcon)

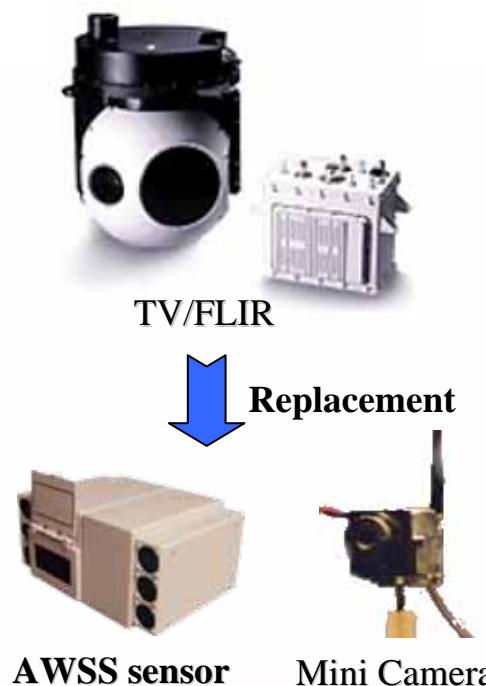
Talks are under way between ADD and US Army.

AWSS Components

Falcon Vehicle (Modification)



LCS (Development)



TV/FLIR



Replacement

AWSS sensor

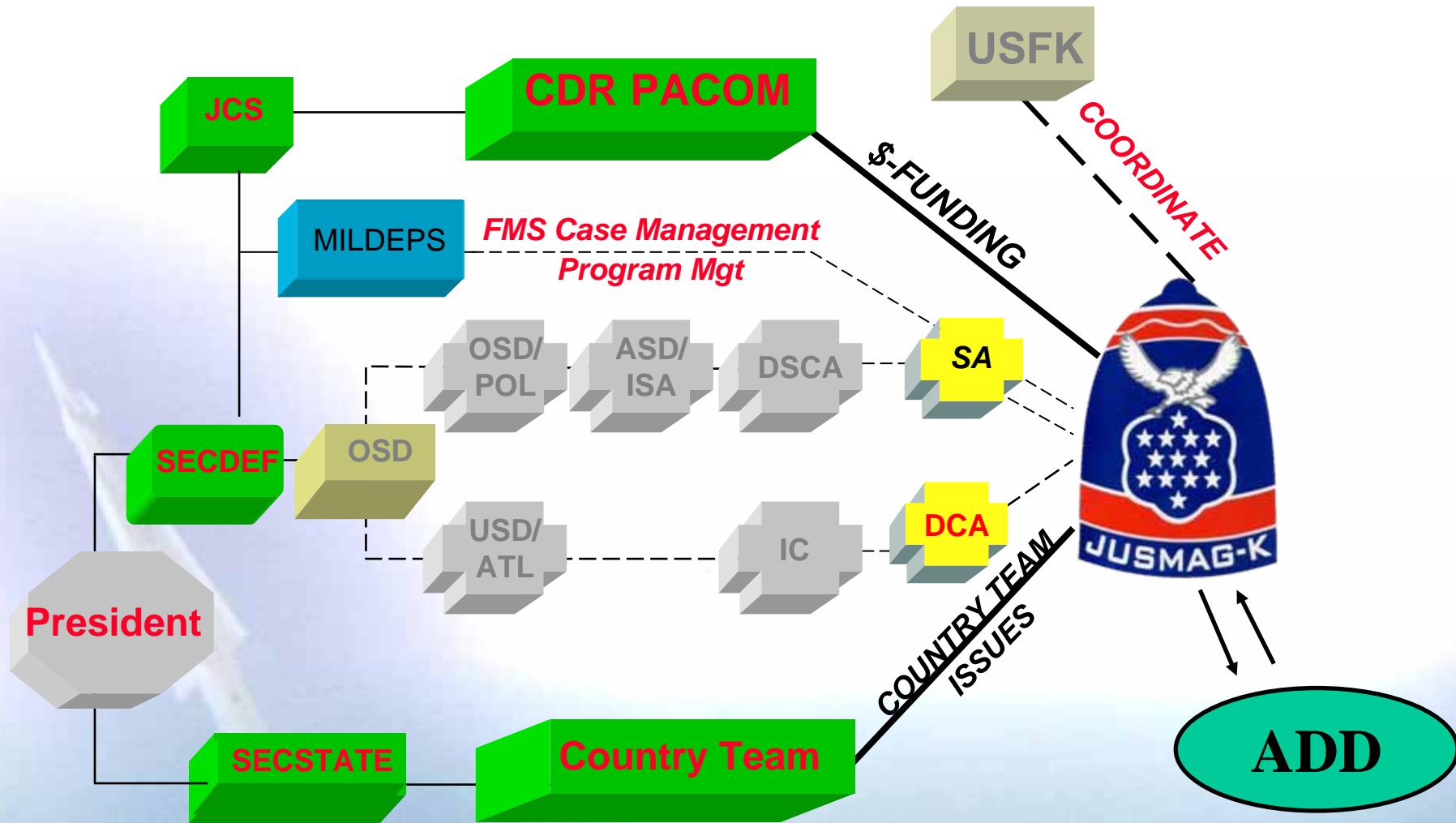
Mini Camera

* LCS : Launch & Recovery Control Station

Positive Signs for Cooperation

- ◆ Has taken a long time to come to present status
- ◆ Shift from DEA to PA, PA to Co-Development takes place
- ◆ The seeds we have sown for 50 years start to sprout

JUSMAG-K was behind the Scenes



Conclusions

- ▶ RoK Battle Lab program introduced
- ▶ Current cooperation status briefly reviewed

ADD is looking for more opportunities:
e.g. LOGIR, M&S, GPS, C3...

- ▶ International cooperation is viewed as a means of delivering capability faster and cheaper to the warfighter



Nuclear, Chemical and Biological Defense Research and Development

*Pacific Operational Science & Technology
Conference*

4 April 2007

***Dr. Tom Hopkins
A/ATSD(NCB)***



Outline

- ATSD(NCB)
- Strategic Guidance
- Oversight Framework
- R&D Portfolio
- Current Capability Needs
- Emerging Threats



Secretary of Defense

**Under Secretary of Defense
for
Acquisition, Technology and Logistics**

**Assistant to the Secretary of Defense
for Nuclear and Chemical and
Biological
Defense Programs**

Counterproliferation,
Cooperative Threat
Reduction and Treaties

Chemical and Biological
Defense and Chemical
Demilitarization Programs

Nuclear Matters

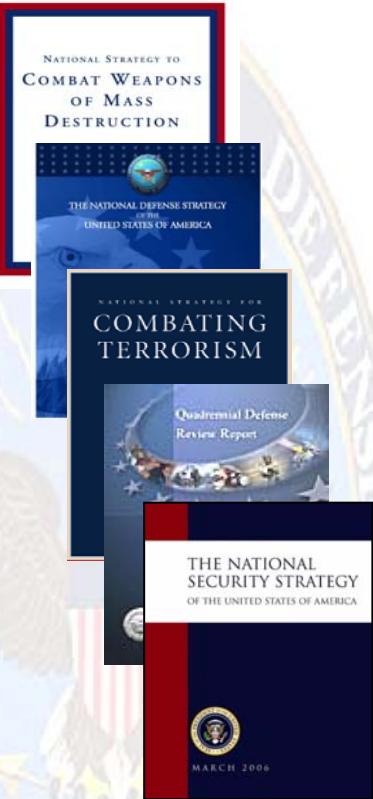
Defense Threat Reduction
Agency



ATSD(NCB)

- **Principal Staff Assistant**
 - Advise the Secretary, Deputy Secretary, and USD(AT&L) on nuclear matters and chemical and biological defense programs.
- **Direction and Oversight**
 - Provide strategic direction and oversee DoD WMD threat reduction activities, combating WMD.
- **Resource Alignment**
 - Assess resource alignment with high level guidance to prevent, defeat, and protect against current and emerging WMD threats.
- **Integration**
 - Ensure research and development, multilateral cooperation, tailored threat reduction strategies and deterrence concepts are applied as integrating functions.

Strategic Guidance

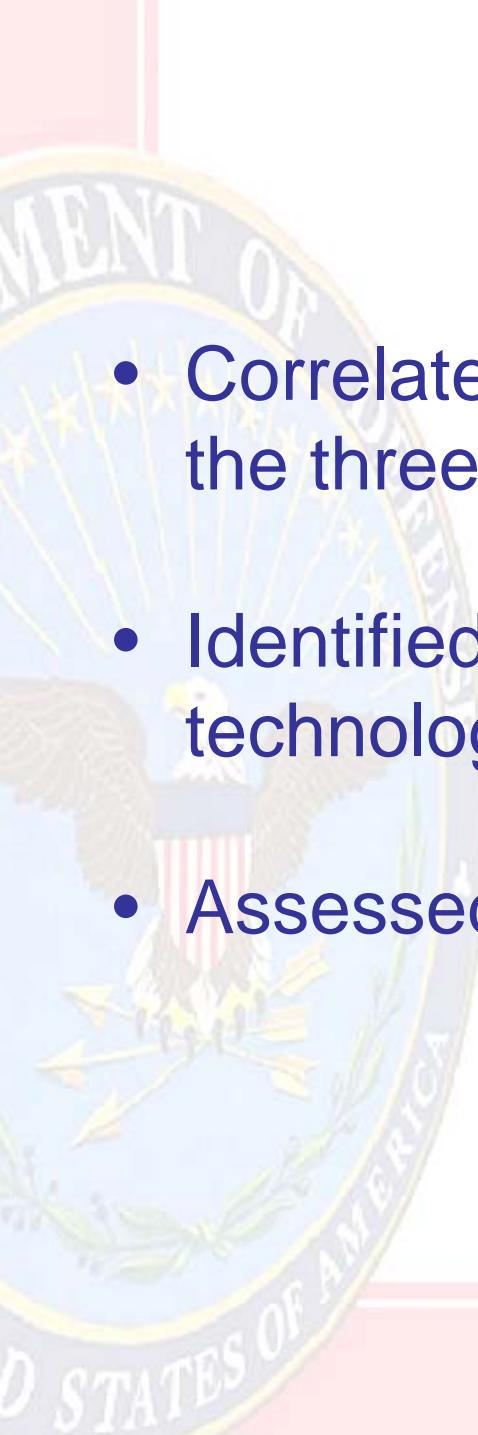


- **High-level guidance includes three goals related to WMD proliferation:**
 - Prevent WMD proliferation
 - Deter, Defend and Defeat WMD use
 - Mitigate Consequences of WMD use
- **Military framework establishes eight operational missions to accomplish goals**
 - Interdiction, Cooperative Threat Reduction, Security Cooperation
 - Elimination, Offensive Operations, Active Defense
 - Passive Defense, Consequence Management
- **ATSD(NCB) focuses on DoD capabilities to achieve these goals**



Oversight Framework

- **WMD threats include potential adversaries who:**
 - Want WMD: Nonproliferation
 - Have WMD: Counterproliferation
 - Use WMD: Consequence Management
- **U.S. needs a spectrum of capabilities:**
 - *Nonproliferation to prevent WMD spread*
 - Threat reduction cooperation
 - Security cooperation and partnership activities
 - *Counterproliferation to defeat WMD*
 - Interdiction
 - Elimination
 - Active defense
 - Offensive operations
 - Passive defense
 - *Consequence Management to protect against WMD use*
 - Consequence management

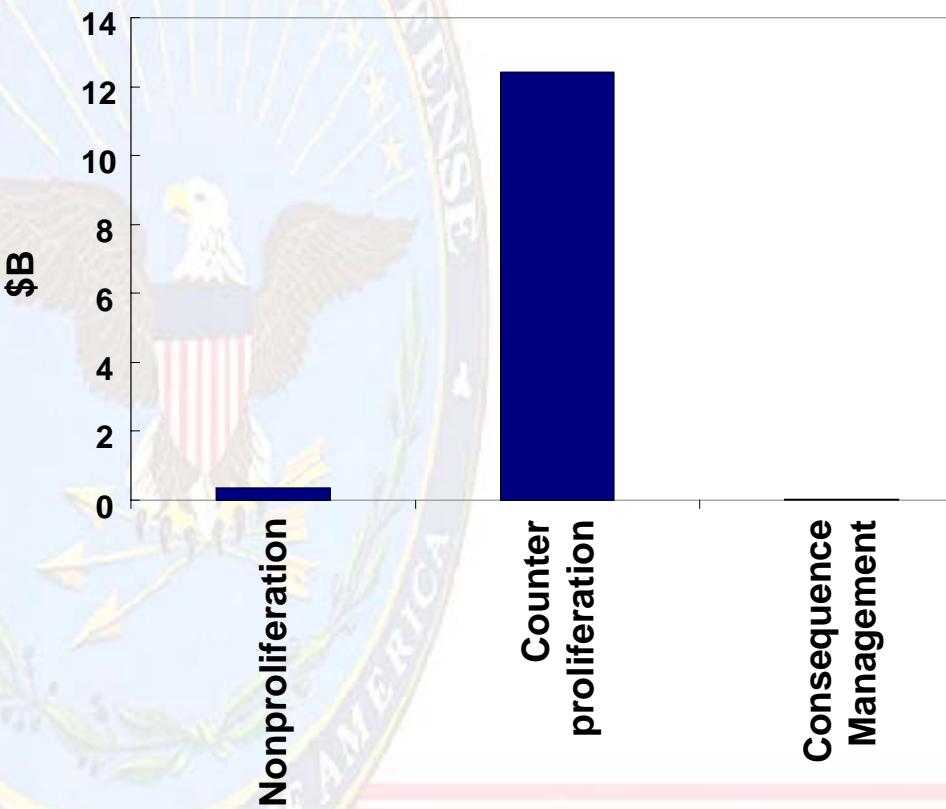


R&D Portfolio

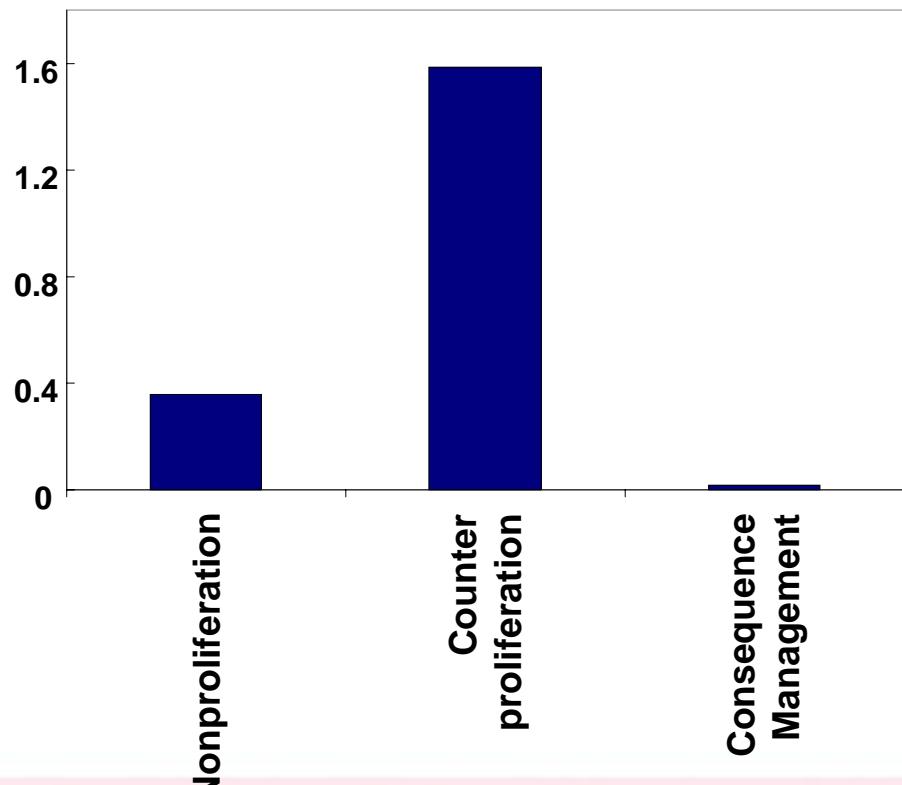
- Correlated Combating WMD R&D programs with the three pillars and eight mission areas
- Identified mission-unique and cross-cutting technology areas
- Assessed the investment portfolio

FY2007 DoD R&D Investments

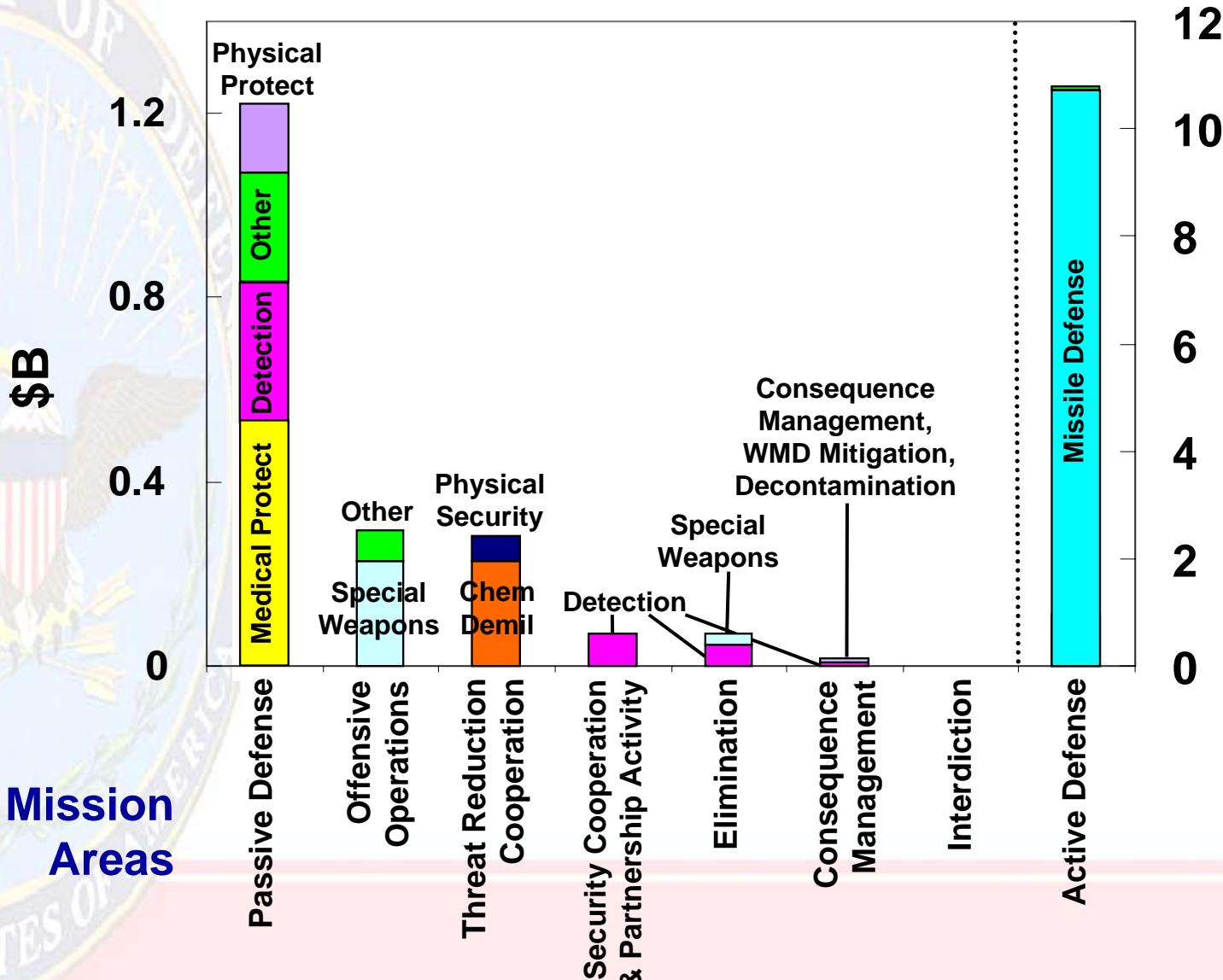
R&D including missile defense



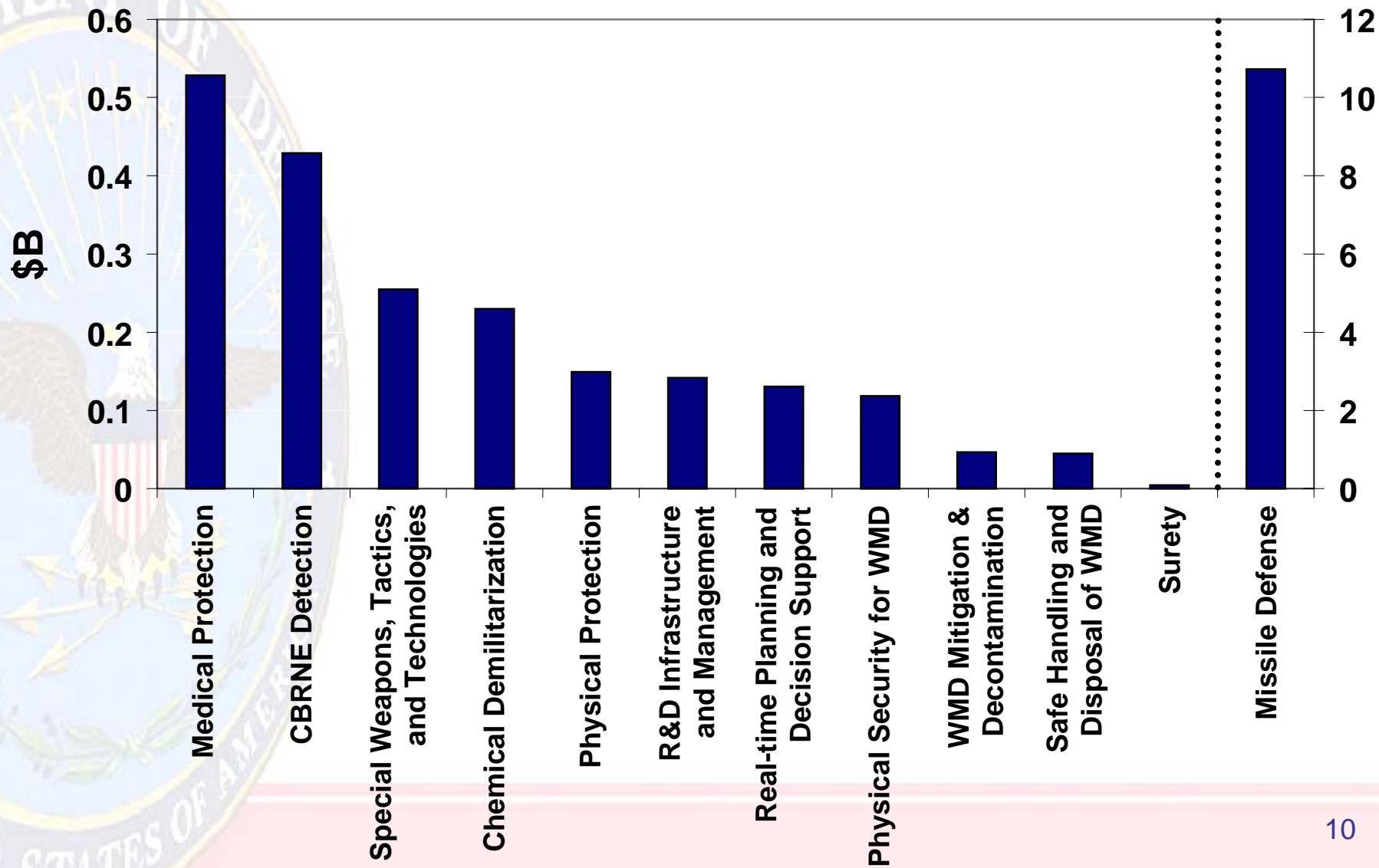
R&D excluding missile defense



FY2007 DoD R&D Investments



Technology Areas



Crosscutting Technologies

Mission Areas

Technology Areas

| | Security Cooperation | Threat Reduction Cooperation | Interdict-ion | Offensive Operations | Elimination | Active Defense | Passive Defense | Consequence Management |
|---|----------------------|------------------------------|---------------|----------------------|-------------|----------------|-----------------|------------------------|
| CBRNE detection | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Physical methods for protection | | | | ✓ | | | ✓ | ✓ |
| Medical protection | | | | | | | ✓ | ✓ |
| Specialized weapons, tactics, and technologies | ✓ | | | ✓ | ✓ | ✓ | | |
| Consequence management and WMD effects mitigation/decontamination | | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ |
| Real-time planning and decision support | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Physical security for WMDs | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| RDA infrastructure and management | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| International cooperation activities and WMD demilitarization | ✓ | ✓ | | | | | | ✓ |
| Safely handle and dispose of WMD (and explosives) | | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| Tailored Strategies | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

All technology areas support more than one mission

Portfolio Summary

- **Nonproliferation**
 - Predominantly domestic Chemical Demilitarization
 - Focused on detection for arms control applications, arms control information technology, and nuclear physical security
- **Counterproliferation**
 - Active defense investments are largest, dominated by missile defense
 - Focused on physical protection, offensive operations medical countermeasures, decontamination, and detection
- **Consequence Management**
 - Focused on technical reachback, nuclear forensics and technologies for civil support teams

R&D Addresses Command Needs

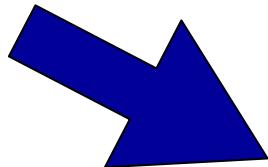
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- Consequence Management
 - Focused on technical reachback, nuclear forensics and to test technologies for civil support teams

12

Command Priorities

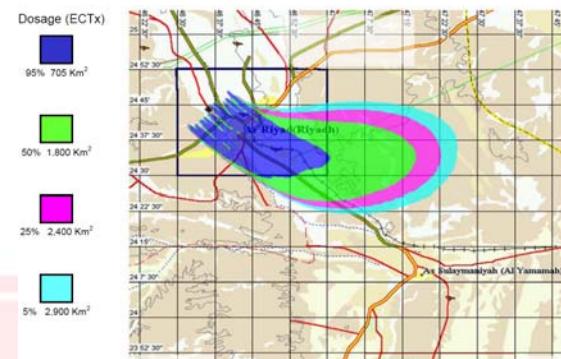
- Persistent surveillance
- Adversarial intent
- Missile defense
- Overcoming integrated air defense systems
- Fast transportation and fast ships
- International military education and training
- Foreign consequence management
- Preferred munitions
- Prompt, hard target defeat capability
- Pandemic preparation



Current Capability Needs

Detection, Identification, and Characterization of CBRN Threats

- Detect WMD at operationally relevant distances
- Track WMD and related materials
- Real-time reachback for technical support for detect, identify and characterize
- Application to targeting, weaponeering, bomb damage assessment, treaty compliance, border security, decontamination, demilitarization, force protection, and other operational applications



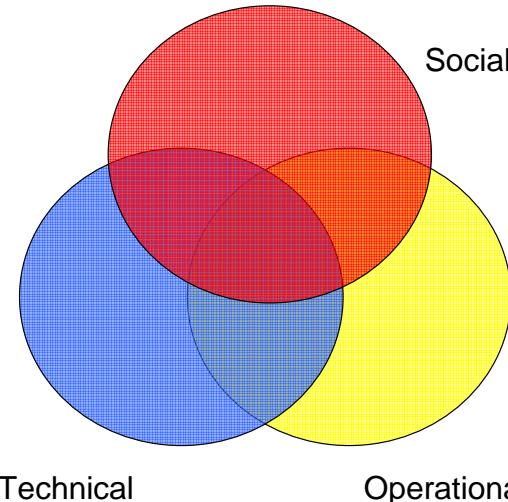
Current Capability Needs

Decision Support and Planning

- Indicators and understanding of adversarial intent
- Rapid processing of intelligence and dissemination to appropriate decision points allowing rapid action
- Information exploitation

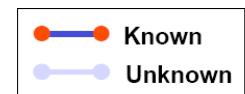
JTAC the joint threat anticipation center

Proliferation Pathway Dimensions



Technical

Operational

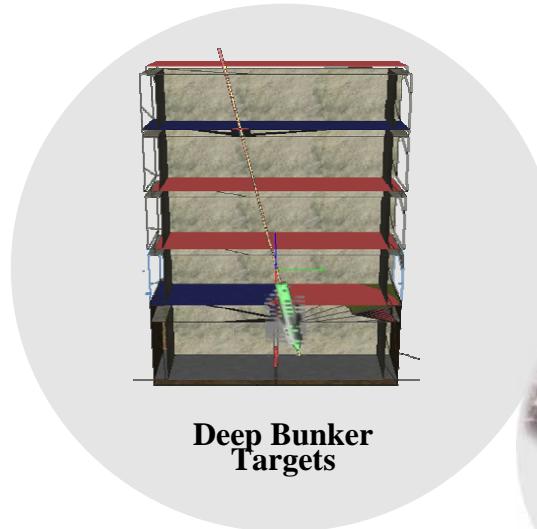


Copyright 2005 © University of Chicago

Current Capability Needs

Offensive Operations

- Defeat WMD targets
 - Hard and deeply buried targets
 - Tunnels
 - Bunkers
 - Agent defeat technologies
- Secure, neutralize, store, and destroy or dispose of WMD



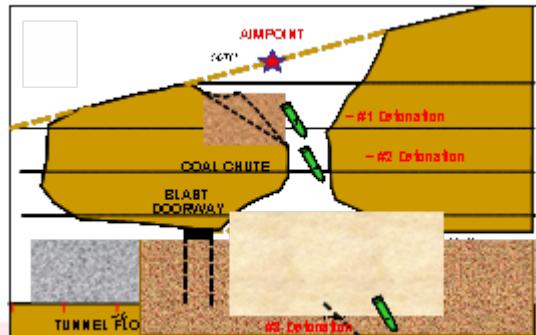
Deep Bunker Targets



Tunnel Targets



Tunnel defeat tests



Hard Target Defeat

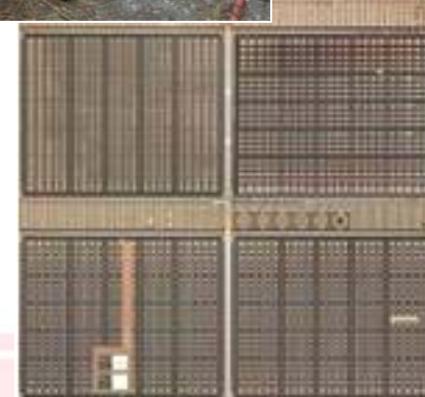


Tunnel Tests

Current Capability Needs

Protection

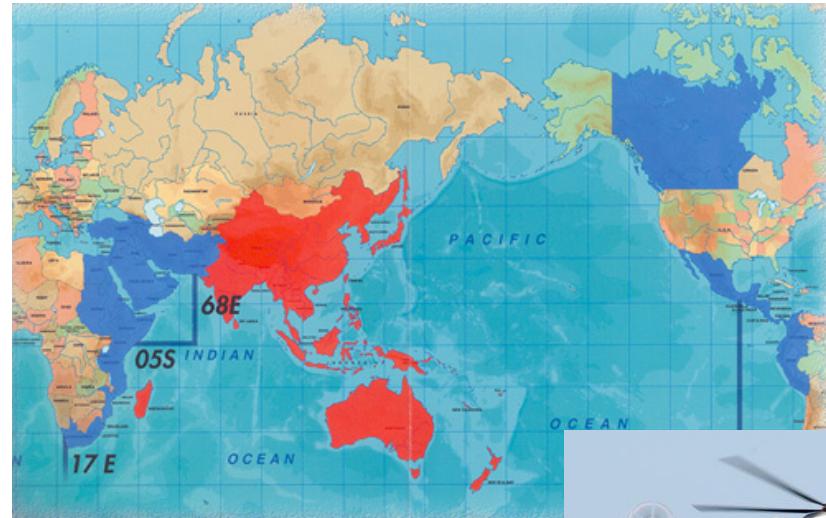
- Medical countermeasures
 - Vaccines and broad spectrum therapies
 - Medical prophylaxis
- Medical response, especially active syndromic surveillance coupled to mass treatment and quarantine
 - Bio-surveillance capabilities
- People, facilities, and mission protection



Current Capability Needs

Security Cooperation

- Interagency and international data exchange, coordination, and training
- New partnerships, agreements, and initiatives





Observations

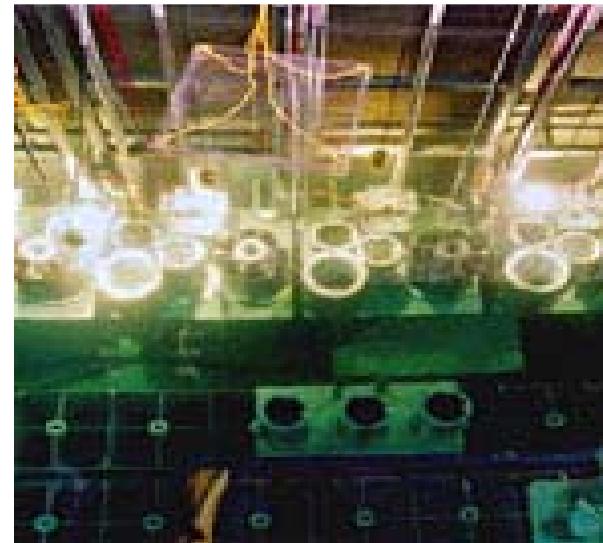
- CBRN detection investment is significant
 - Challenges: Stand-off detection, identification and characterization
- Decision support tools are embedded in larger systems
 - Challenges: Real-time situational awareness and threat anticipation
- Offensive operations R&D investments are dominated by hard and deeply buried target and agent defeat
- Protection is single largest technology area
 - Medical protection dominates and remains the biggest challenge
- Security cooperation R&D...future requirements?

Emerging Threats



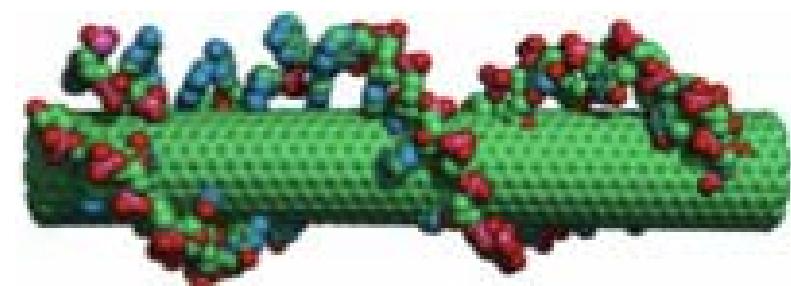
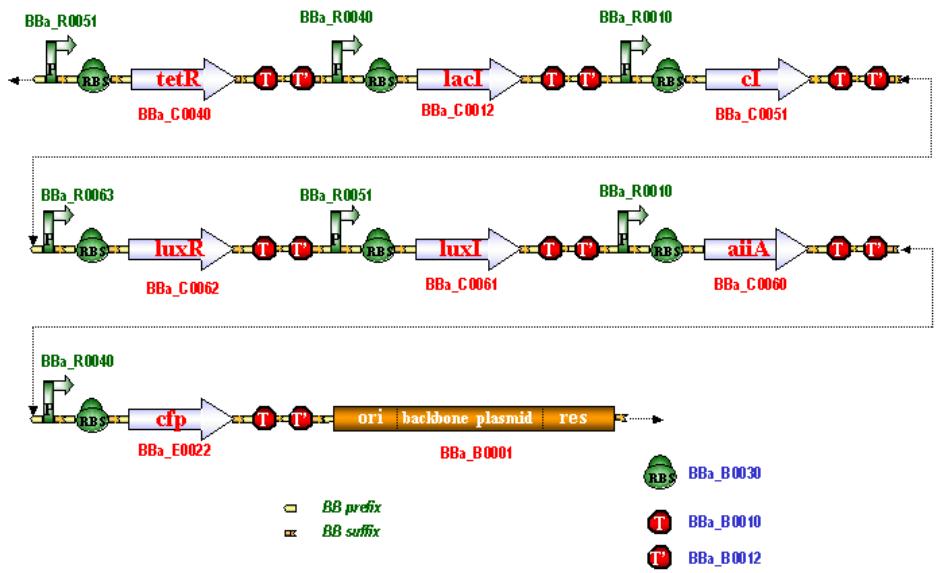
Emerging Threats

- Nuclear Proliferation
 - New nuclear weapons states
 - Acquisition of nuclear weapons by non-state or sub-state actors
- Natural Pandemics
 - Global connectivity and modern transportation are accelerating vectors for transmission
 - Security and social aspects
 - Emerging public health threats can also become BW threats



Emerging Threats

- Biotechnology
 - Dual-use technology
 - Genetic engineering
 - Synthetic biology
- Nanotechnology
 - Nano-enabled biochemical agents and energetic materials
 - Circumventing vaccines and evasion of medical countermeasures
 - Anti-material agents





Emerging Responses

Responses to emerging threats will require the full spectrum of R&D, operational, intelligence, political measures and international partnerships



ATSD(NCB) Challenges

- Assess and improve the Combating WMD R&D investment strategy
 - Guidance
 - Current needs
 - Emerging threats
- Ensure that R&D communities communicate and collaborate with stakeholders



Army Science & Technology Overview



4 Apr 2007



*Dr. Thomas H. Killion
Deputy Assistant Secretary
for Research and Technology/
Chief Scientist*



Outline

- ***Science and Technology (S&T) Strategy***
- ***Warfighter Guidance and Drivers***
- ***Technology Area Investments***



Science & Technology for a Campaign Quality Army with Joint & Expeditionary Capabilities

Current Force



~100 lb. load



Limited network



> 70 tons



< 10 mph

Enhancing the Current Force

**Science and Technology—
develop and mature
technology to enable
transformational
capabilities for the
Future Force while seeking
opportunities to accelerate
technology directly into
the Current Force**

Enabling the Future Force

Future Force



**< 40 lb.
load**



Fully networked



< 30 tons



> 40 mph



From Science to Technologies...Systems

3 Different Types of S&T Investments

S&T
PB08

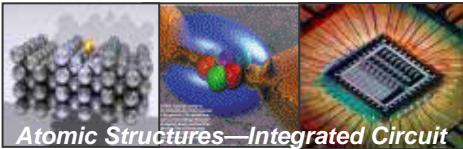
\$1.7B

Development

Acquisition

6.1: Basic Research 18% of S&T

Nanoscience

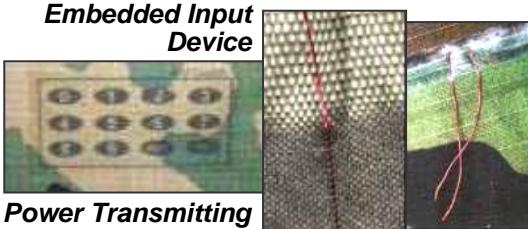


- Understanding to solve Army-unique problems
- Knowledge for an uncertain future

6.2: Applied Research 40% of S&T

Integrated Textile Conductors

Embedded Input Device



- Applications research for specific military problems
- Components, subsystems, models, new concepts

6.3: Advanced Technology Development 42% of S&T

Precision Air Drop—50 meters



- Demonstrate technical feasibility at system and subsystem level
- Assess military utility
- Path for technology spirals to acquisition—rapid insertion of new technology

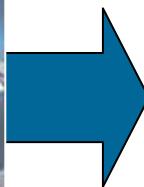
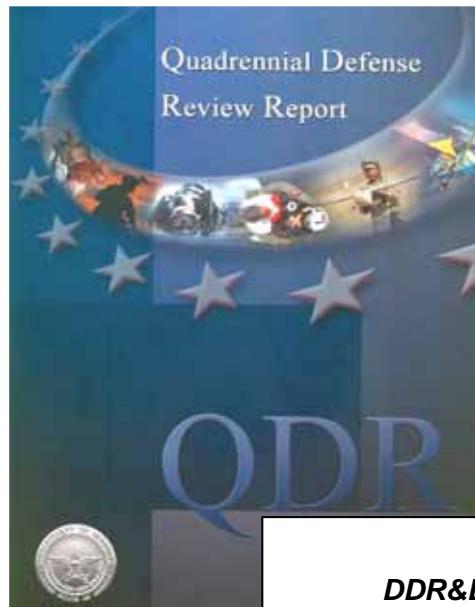
Far Term

Mid Term

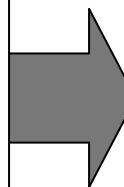
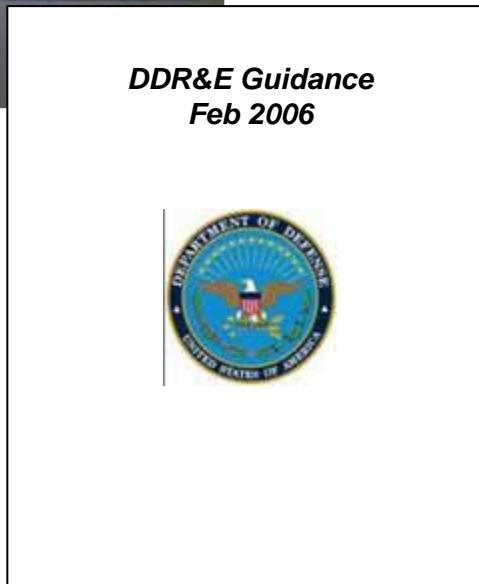
Near Term



OSD Planning Framework



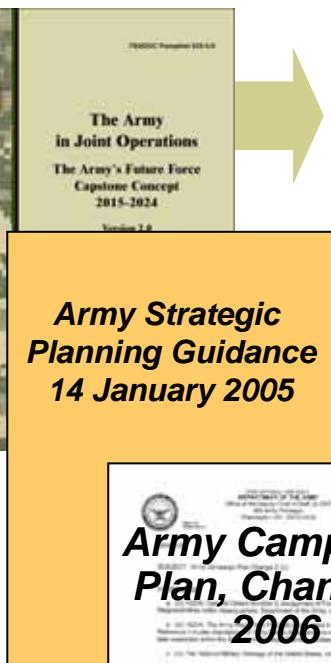
Enhance our expeditionary combat power and shape the Services to be lighter, yet more lethal, more sustainable and more agile



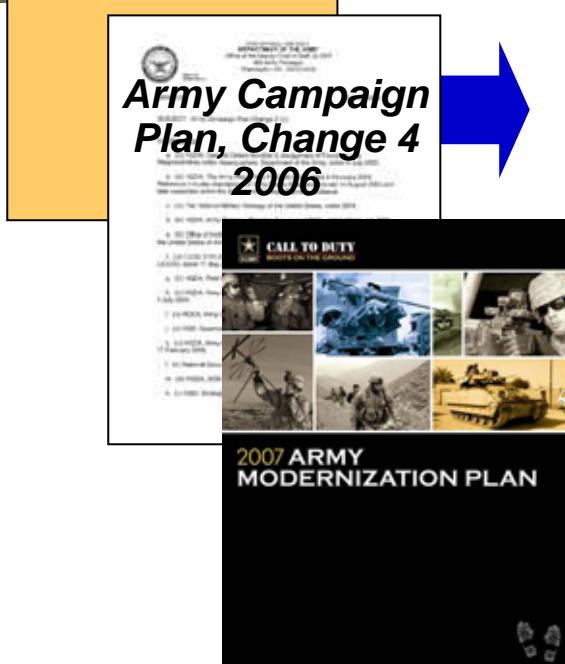
Protection, Battlespace Awareness, Force Application, Focused Logistics—implementing QDR guidance



Army Level Guidance



"The FCS further encompasses a set of technologies and capabilities that will spiral into the entire Army as they mature. Networked C4ISR, precision munitions, and advanced fire control will also be key enablers."



"...provide relevant and ready land power capability to the Combatant Commander as part of the Joint Team"

"... provide relevant and ready land power to combatant commanders and the Joint Force..."

"The Army's investment strategy pursues technologies to achieve the goal to field forces that are "lighter yet more lethal, more sustainable and more agile" while achieving entirely new capabilities..."



TRADOC Capability Gaps— Shaping S&T Programs



Emerging Top Challenges for Current Force 2006



- Networked Enabled Battle Command
- Protect Force in Counterinsurgency Operations
- Soldier Protection in Counterinsurgency Environment
- Logistics and Medical in Counterinsurgency Operations in non contiguous battlespace
- Train the Force How and As it Fights
- Tactical Communications
- Ability to Conduct Joint Urban Operations
- Joint Interoperability, Coalition and Interagency Operations
- Enhanced ISR Capabilities
- Timeliness of Analysis, and Information Dissemination



Future Force Capability Gap Areas



- Enhanced Soldier Protection
- Modular, Scalable and Tailorable Battle Command and Control
- Enhance Platform/Group Protection
- Dynamic, Uninterrupted Communications Network
- Sustainment of Modular Forces
- Enhanced Collection, Exploitation and Dissemination
- Strategic Force Projection/Intratheater Operational Maneuver and Sustainment
- Modular, Tailorable Forces
- Capability for Lethal/Non-lethal Overmatch
- Ability to Train the Force How and As it Fights



Responding to Joint Needs



Integrated Priority List

Integrated Priority List

Integrated Priority List

...



Technology Area Investments to Satisfy Gaps—New Capabilities

FY08 \$1.7B

Force Protection
\$331M

ISR \$164M

C4 \$138M

Lethality \$168M

Medical \$136M

Soldier \$119M

Logistics \$90M

Rotorcraft \$70M

Unmanned Vehicle \$69M

Classified \$51M

Mil Eng & Environment \$44M

Advanced Simulation \$42M

Basic Research
\$306M

Enabling the Future Force

Enhancing the Current Force

Army
Concept & Capability
Developments Plan
(AC2DP)

2006-2013

Version 1.0
Final
8 September 2006



TAB001_PlanProg10_05-04

The Army
in Joint Operations

The Army's Future Force
Capstone Concept
2015-2024

Version 2.0

2015-2024

7 April 2006

040407_Killion_PACOM_Final





FCS Brigade Combat Team



Manned Ground Vehicles (MGV)

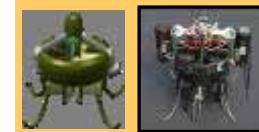
Infantry Carrier Vehicle (ICV)



Mounted Combat

Unmanned Aerial Systems (UAS)

Class I UAV



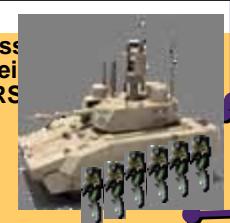
Class IV UAV



Command and Control Vehicle (C2V)



Reconnaissance And Surveillance Vehicle (RSV)



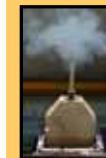
Common Chassis

Advanced Lightweight Armor

Engine



Non-Line of Sight Mortar (NLOS-M)



Unattended Ground Systems (UGS)

T-UGS



U-UGS



Tactical and Urban Unattended Ground Sensors



Non-Line of Sight Launch System (NLOS-LS)

FCS Recovery and Maintenance Vehicle (FRMV)



Medical Vehicle – Treatment (MVT)



Medical Vehicle – Evacuation (MVE)

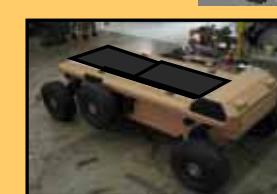


Multifunction Utility/Logistics and Equipment Countermeasures and Transport



Unmanned Ground Vehicles (UGV)

Armed Robotic Vehicle – Assault (Light) (ARV-A-L)





Support to Current Operations

Demonstrations, Prototypes, or Limited Fieldings

Countermine/ Counter Boobytrap



WARLOCK Jammers



Explosive
Detection



Change Detection
Workstation

Enhanced Lethality



Acoustic
Gunfire
Detection
System

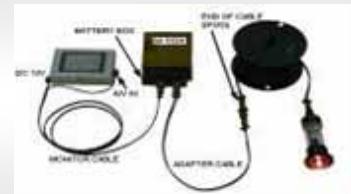


SWORDS

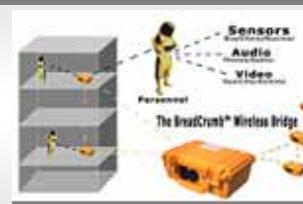


Special
Purpose
Munitions

Network



Well
Camera



Secure
Wireless
Relays



Satellite
Nodes

Power & Energy



Zinc-Air
Battery
Family



"AA"
Battery
Solar
Charger



SATCOM &
Javelin Hybrid
Power Sources

Survivability



Integrated
Rocket, Artillery,
Mortar (RAM)
Detection



Backstop



Current Force—Force Protection

Platform Protection



Stryker w/Bar Armor



Expedient HMMWV Armor Kit



Tactical Vehicle Add-on Armor



Tear-off Windshields



Deltoid Axillary Protection



Interceptor Body Armor



Vehicle Class Body Armor Support System



SAPI Plates

Counter Rocket Artillery Mortar



Unattended Transient Acoustic MASINT System (UTAMS)



Backstop



Lightweight Counter Mortar Radar



Airborne Detection



Neutralization

Countermine/Counter Boobytrap

Detection, Surveillance, Neutralization and Defeat



Robotic Detection/Neutralization



Future Force—Force Protection

Platform Protection



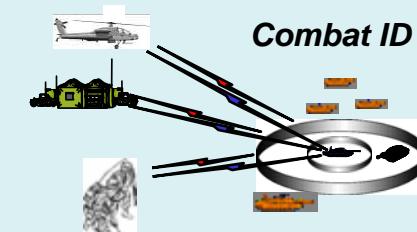
Structural Armor



Active Protection



Laser Vision Protection



Combat ID



Integrated Rotorcraft Protection

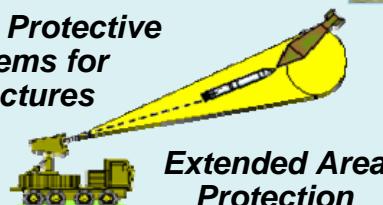
Counter Rocket Artillery Mortar



Modular Protective Systems for structures



Solid State Laser (SSL) Weapon System Concept



Extended Area Protection

Countermine/Counter Boobytrap

Detection,
Surveillance,
Neutralization
and Defeat

Networked
Electronic Warfare



Packbot w/ sensor



Concealed Explosives Detection



Current Force—ISR and C4

Command & Control



Urban Tactical Planner (UTP)



Agile Commander



Airborne Network Extension



Extended Range Communications (Breadcrumb)

Networked Comms



Tele-engineering



Integrated Meteorological System

Surveillance & Sensors

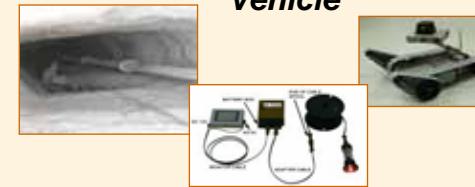


Overwatch—Detection & Classification of Hostile Fire



IR Sensors for Small Raven & Pointer

Well Camera & Remote Robotic Vehicle



Mobile Stabilized Panoramic Sight



Wide Field of View Night Vision Goggle



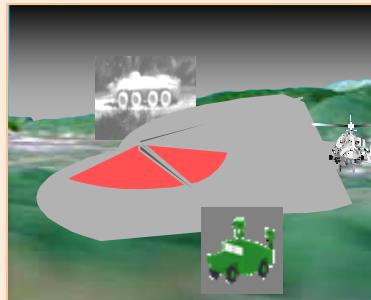
Pilar Gunfire Detection System



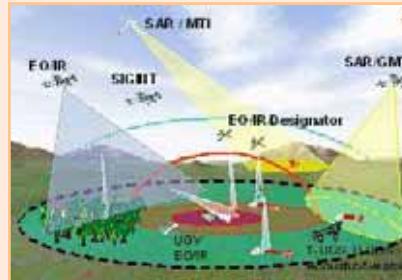
Future Force—ISR and C4

ISR
C4

Persistent Sensor Coverage



3rd Gen Infrared Sensors



Layered Networked Sensors

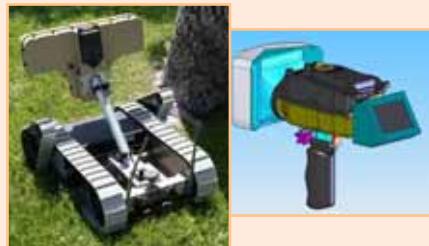
Command & Control

Knowledge Fusion



Flexible Displays

MOUT/Situational Awareness



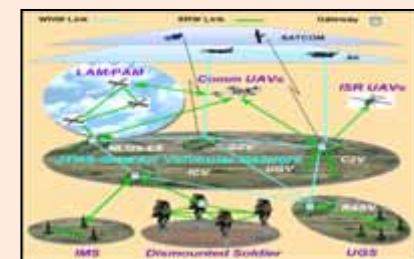
Through Wall Sensing



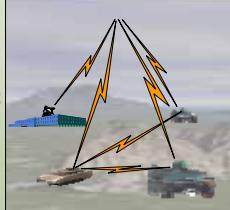
C2 in Urban Terrain

- **Find the Enemy**
- **Assured Comms**
- **Battle Command**

Tactical Mobile Networks



Advanced Antennas



Tactical Network & Communications Antennas

Directional Antennas

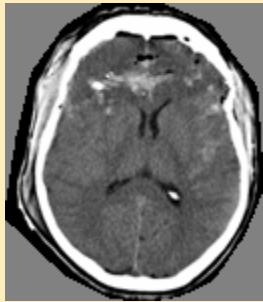
Pos/Nav Network Assisted and Improved MEMS IMUs





Future Force—Medical

Medical



Improved Treatment for Head Injuries

Combat Casualty Care



Regenerative Therapies



Far-Forward Resuscitation & Hemorrhage Control



Semi-Autonomous Intensive Care & Transport System

Infectious Diseases



Malaria Treatment Drugs

Malaria Prevention Vaccines



Malaria Rapid Diagnostic Device



Dengue Prevention Vaccines



Performance Test for Future Lightweight Body Armor Systems



Operational Medicine

Remote Monitoring of Warfighter Health and Performance



Future Force—Soldier Systems

Soldier

Survivability

Modeling & Simulation

Nanomaterials for Ballistic, Laser, Environmental Protection

Novel Fibers for Ballistic Protection

Rations

First Strike Compact Ration

Biosensor for Food Safety

Joint Combat Feeding

Power

Fuel Cell Battery Hybrid

Photovoltaics

Stirling Engine

Electro-textiles

Personnel Technologies

Accessing, Retaining & Training Adaptive Soldiers & Leaders

Realistic, Effective Training

Sensors

Uncooled IR Sensors for UAVs

Physiological Status Monitoring

Pointer



Future Force Warrior (FFW)—2006

- **FFW Increment 1 at C4ISR OTM Jun-Aug 06:**

- Integration into Future Force network via Soldier Radio Waveform
- Current force integration via FBCB2
- Integrated combat ensemble with stand-off body armor/load carriage/electronics and signature management
- Squad level NLOS cooperative engagement
- Headgear with integrated fused thermal and I2
- System voice control

- **FFW Early Increment 2 improvements at OTM 06 and AAEF/Spiral C:**

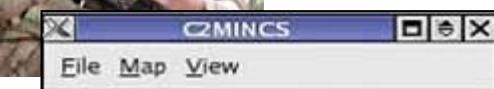
- Beyond squad level NLOS cooperative engagement
- Digital target hand-off to joint platforms (F-16, A-10)
- Class I UAV imagery feed
- Goggle mounted “look down” display
- Physiological status monitoring

- **FFW at C4ISR OTM and AAEF/D in 2007**

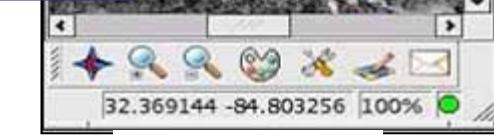
- Precise positioning system
- Low power flexible display demo
- Headgear sensor fusion
- Wireless Personal Area Network and weapons interface
- UGV, UGS integration to FFW platform
- Compact computer (Falcon computer from AFRL)
- Apache digital target hand-off



Leader Display



Soldier Display



FFW transitions to PEO Soldier in 1QFY08 for Ground Soldier System (next generation Land Warrior)



Future Force—Logistics

Logistics

Power & Energy



Hybrid Electric Drive



Fuel
Storage

Heavy Fuel
Engine



Fuel Cell
Development



UNITED STATES ARMY
NAC
NATIONAL AUTOMOTIVE CENTER



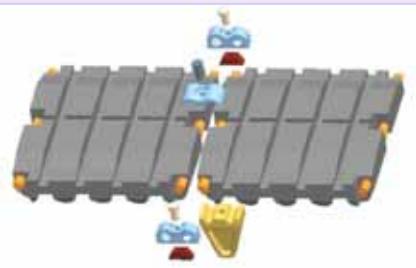
Utility Variant



Sustainment Variant

Future Tactical Truck
System Concepts

Deployability



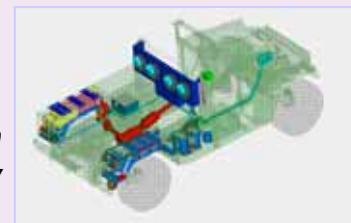
Lightweight Band Track



Precision Air Drop
30k lbs

Sustainment

Water Generation
& Recovery



EM Gun Munitions



Prognostics/
Diagnostics

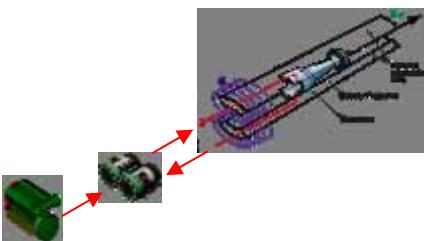




Future Force—Lethality

Guns and Munitions

Electromagnetic Gun...
paradigm shift
in propulsion



Electronically
Controlled
Variable
Effects
Warheads



Wall Breaching
Munitions



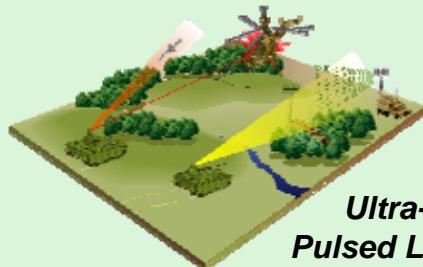
Small Arms
Deployable
Sensor
Network



Urban Assault Munitions

Non-lethal

Multi-Mission High
Power Microwave



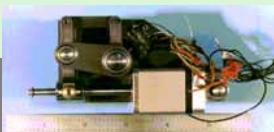
Ultra-short
Pulsed Lasers



Missiles



GPS Receiver



Control Actuators



IMU
Guidance & Control

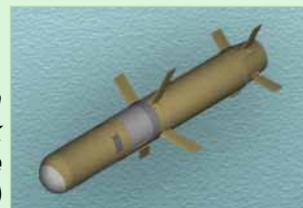


Future Missile Technology



Non-Line of
Sight Launch
System
(NLOS-LS)

Precision
Attack
Missile



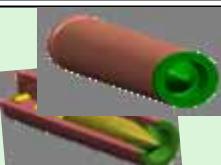
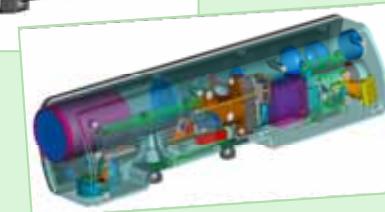
NLOS-LS and C3

Joint Small Arms



Lightweight
Caseless
Ammo

Lightweight
Weapon
Component
Technologies



Target
Acquisition
Fire Control
Sub-system



Future Force—Rotorcraft

Rotorcraft

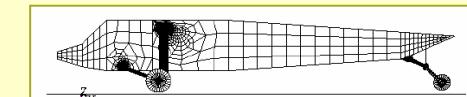
Reduced Operations and Support Costs

Propulsion and Drive Trains

- Increased Fuel Efficiency
- Lighter Weight Components
- Small Heavy Fuel Engine

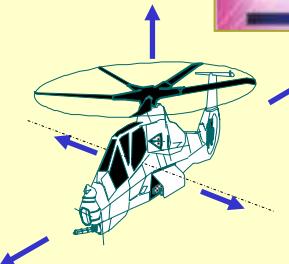


- Reduced Weight/Vibration
- Improved Reliability and Durability



Rotors and Flight Controls

- Intelligent & Active Rotors and Controls
- Embedded Actuators



Platform Technology

- Advanced Rotary Wing Concept Designs
- Aviation Weapons Integration
- Directed Energy/Non-lethal Weapons Integration





Current Force—Advanced Simulation

Advanced Simulation

Psychological Evaluation and Treatment



Cultural Awareness
Simulation



Adaptive Learning
Environment





Joint Fires and Effects Trainer System



Urban Terrain

- Application of indirect effects in urban battlespace
- Cognitive proficiency for better decision-making



Fires & Effects Command (FEC)

- Testbed for system and human/machine interface requirements for Networked Fires Command node



Open Terrain

- Skill and cognitive trainer
- Mounted and dismounted
- Range of “individual” to “collective” tasks



Close Air Support (CAS)

- Movable flats for mixed reality environments
- 300-degree perimeter field-of-view
- 360-degree overhead field-of-view
- All rear projection



Future Force—Training Simulation

Adv Simulation

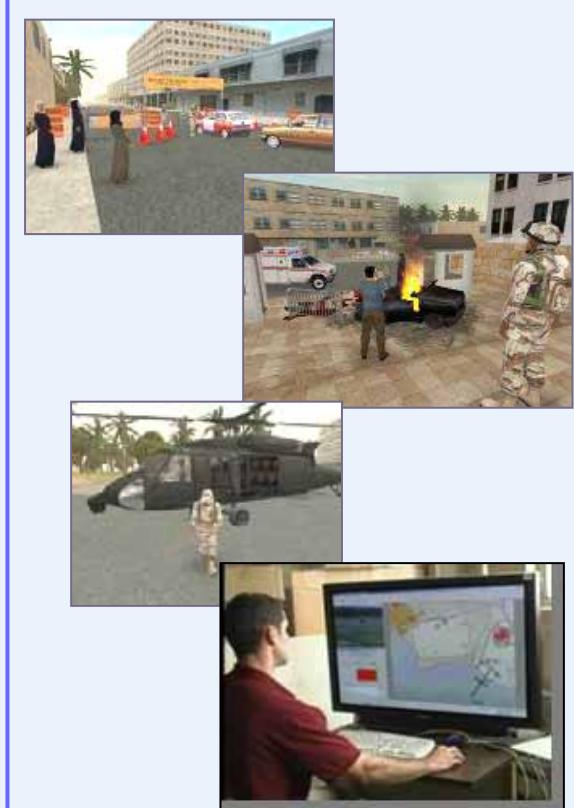
Training Strategies & Simulation



Next Generation Training Systems



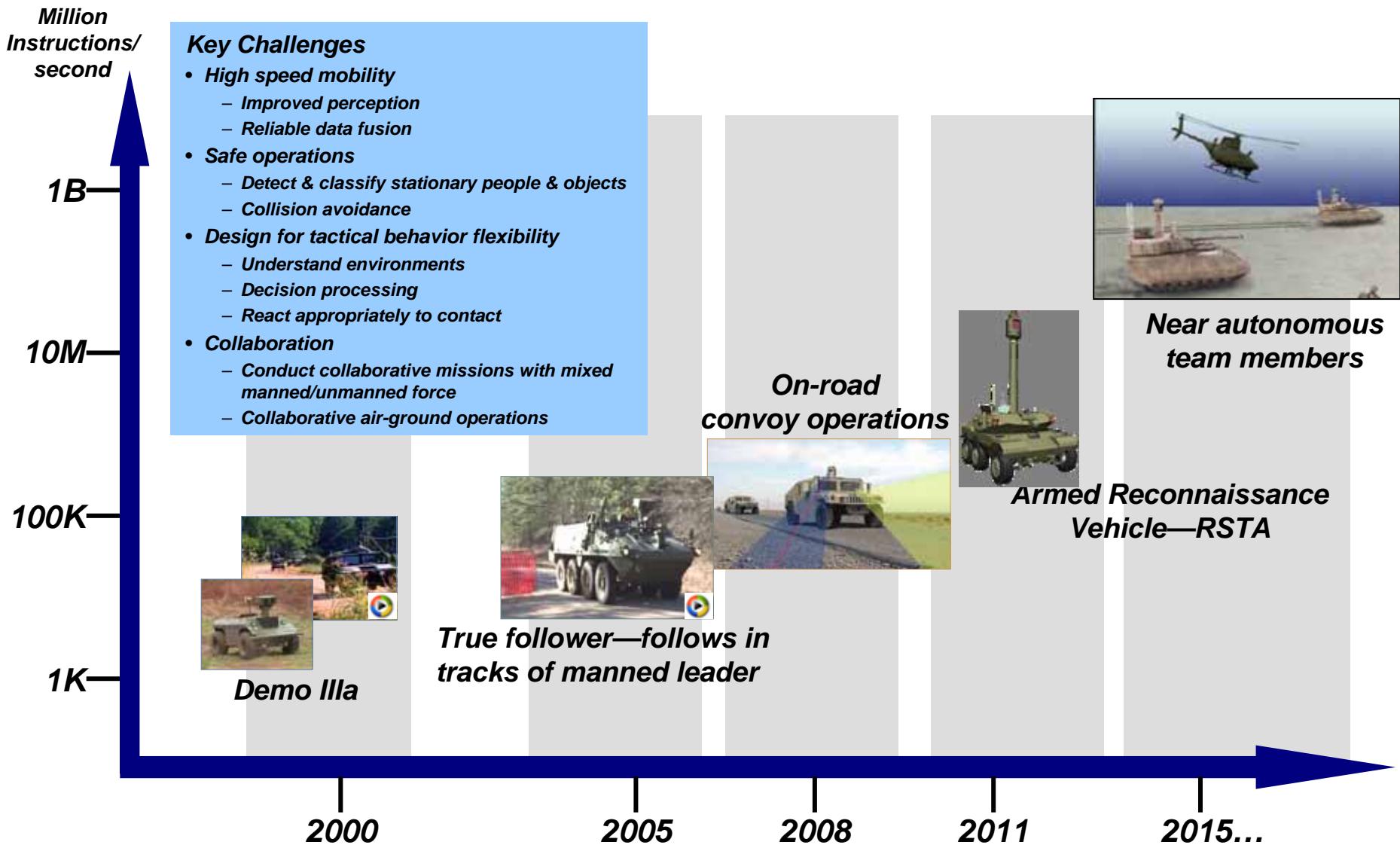
Army Excellence in Leadership



Learning with Adaptive Simulation & Training



Progress in Autonomy & Cognition for Operational Capability

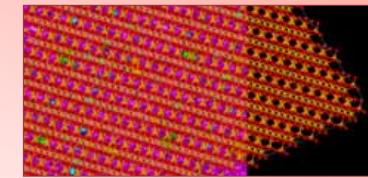
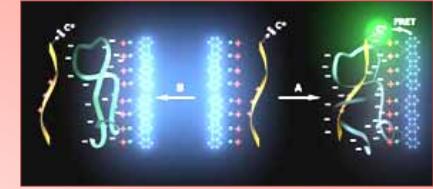




Shortening Cycle Time— Research to Products

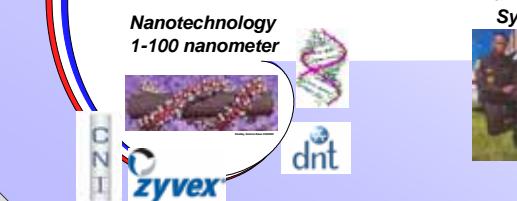


Immersive simulation for training, cultural awareness and mission rehearsal

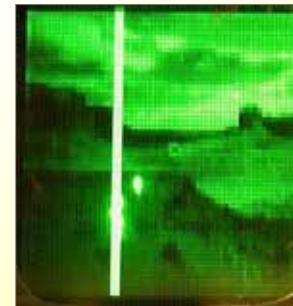


Bio-inspired materials designs for energy, sensors, and networks

Transforming knowledge into Technology



Nanotechnologies for Soldier survivability



Develop high performance, commercially-viable, conformal and flexible displays



Army S&T... *Engine of Transformation*



*The Overall Classification of
this Briefing is
UNCLASSIFIED*



Game Changing Technologies

Computational Imaging Systems

Timothy M. Persons, Ph.D.
Technical Director and Chief Scientist
Disruptive Technology Office
Office of the Director of National Intelligence

April 4, 2007

UNCLASSIFIED

*The Overall Classification of
this Briefing is
UNCLASSIFIED*



How the Disruptive Technology Office is Working to Subvert Pre-21st Century Intelligence Business Paradigms

Case Study: Computational Imaging Systems

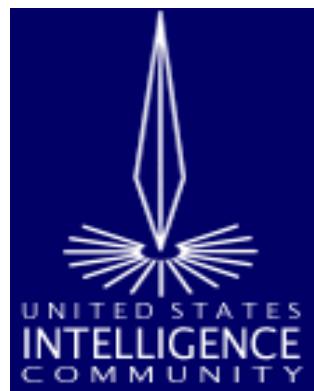
Timothy M. Persons, Ph.D.
Technical Director and Chief Scientist
Disruptive Technology Office
Office of the Director of National Intelligence

UNCLASSIFIED

April 4, 2007

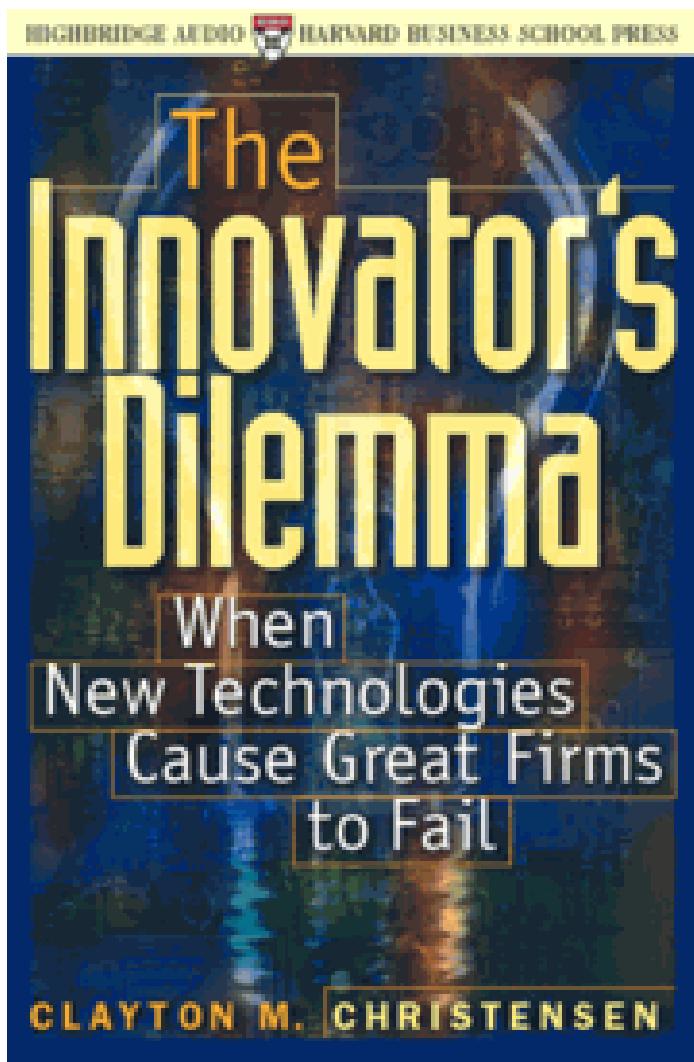


The Nation's Intelligence Community

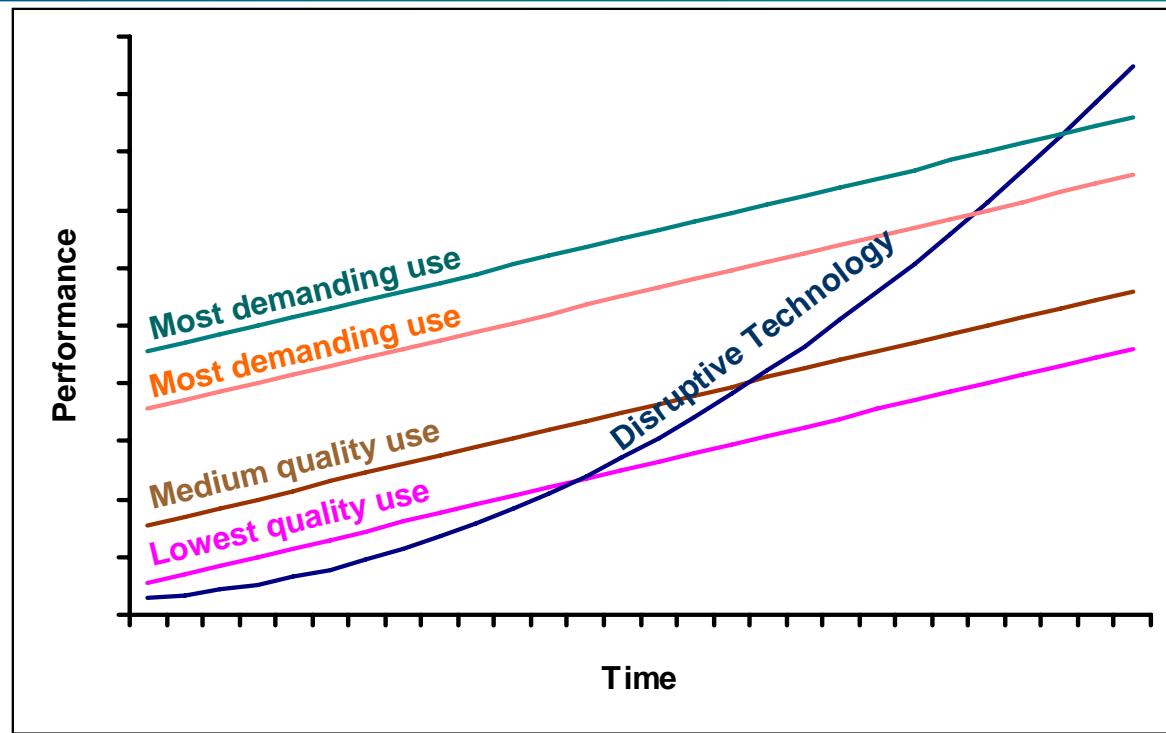




The Innovator's Dilemma



Christensen, Clayton M. *The Innovator's Dilemma*,
Harper Business, 1997, 286 pages

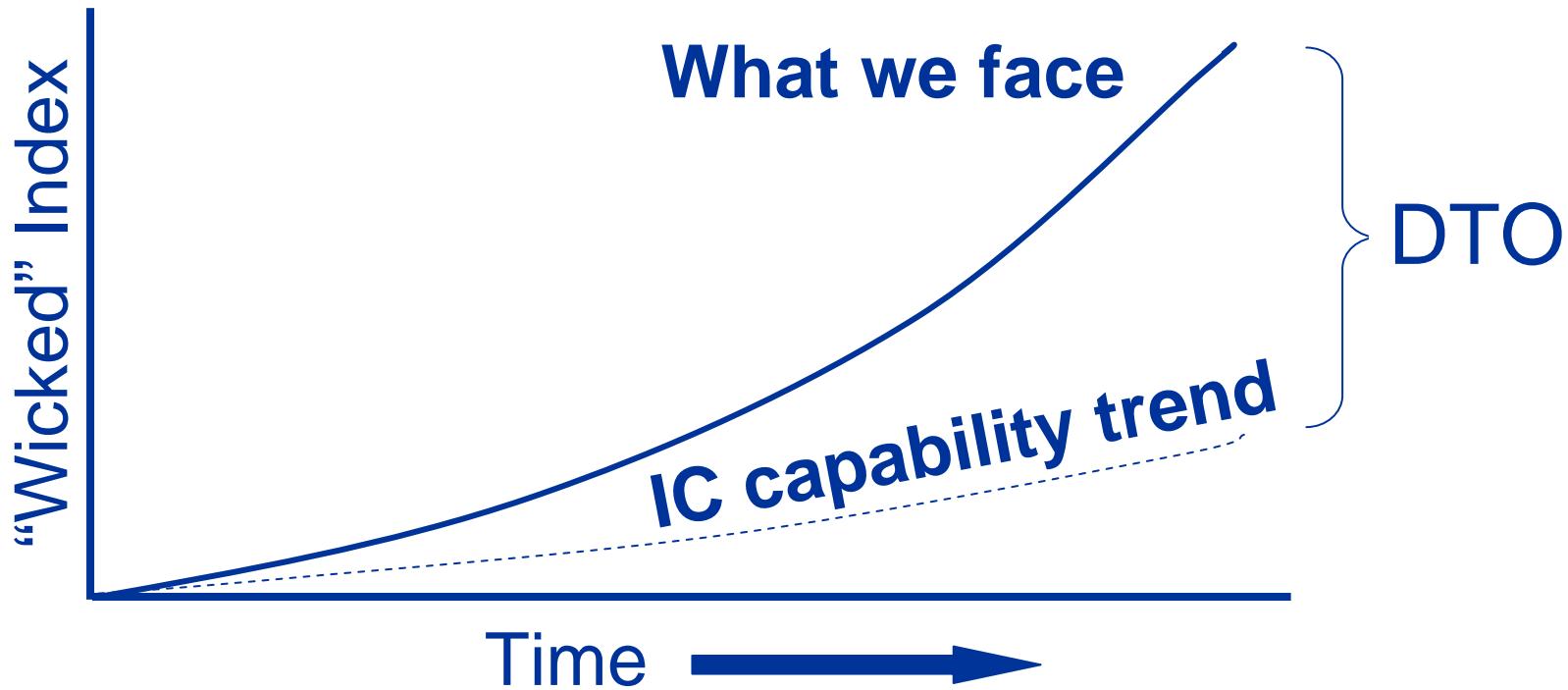


Established
Technology
Silver halide
photo film
Wireline telephony
Manned fighter &
bomber aircraft

Disruptive
Technology
Digital
photography
Mobile telephony
Unmanned
aircraft



DTO Addresses “Wicked” Problems

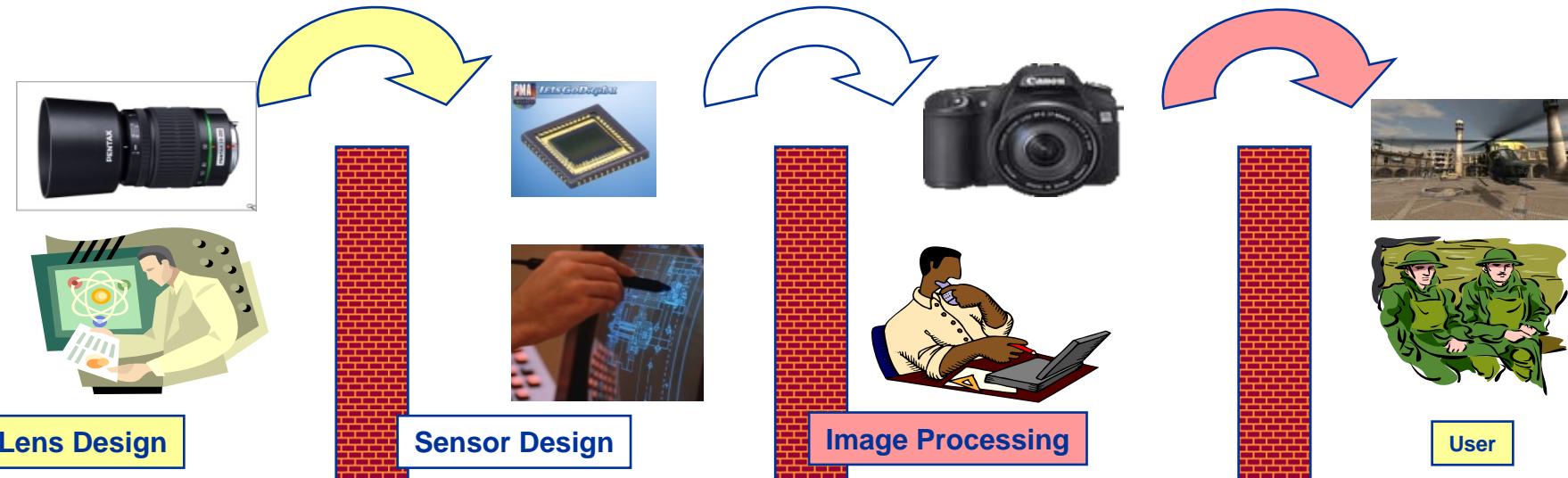




Conventional Approach to Designing Imaging Sensors

n Current imaging sensor design strategy:

- Separately designed and optimized subsystems/components bolted together
- Fixed allocation of resources at design time
- Feed-forward information flow only



Case Study for a Hypothetical Sensor:

Data generated = 1024×1024 (spatial) $\times 200$ (spectral) $\times 8$ bits = 200 MB / frame

Information extracted from a typical tactical scene = 100 objects of interest $\times 4$ B/object = 400 B

(Information / Data) = 10^{-6} ... **VERY POOR EFFICIENCY**

Current High Performance Imaging Sensors



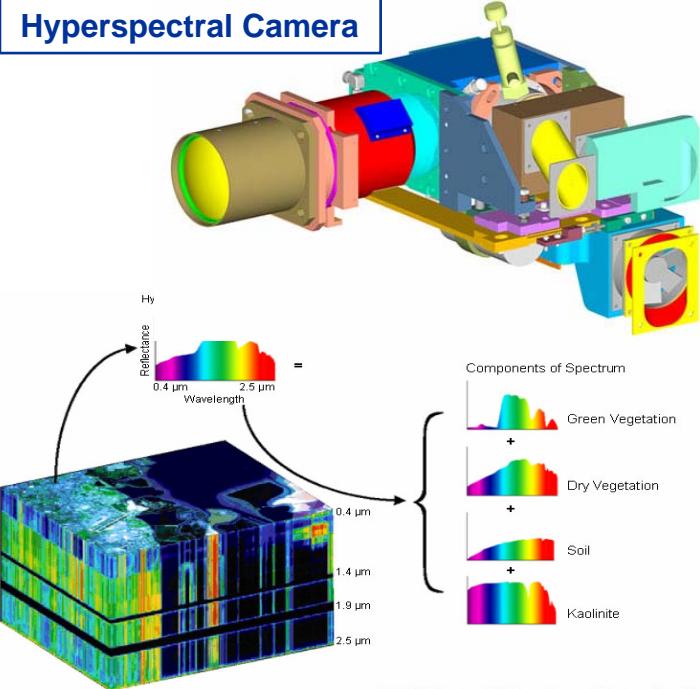
Predator Camera



Predator Radar



39 Megapixel Hasselblad



(NEMO Project Office, United States Navy)

Technology Scaling Driven by “Moore’s Law”

- 3D, hyperspectral, polarimetric, Doppler Radar....
- More detector pixels, more spectral bands, higher frame rates....
- Governing philosophy: **“More data is better data”**



Definition of Computational Imaging Systems

- Sensing systems that exhibit jointly optimized optics, transduction, algorithmic, form factor, power, and information factors which together are tunable and exhibit semi to fully autonomous, purposeful¹ sensing.**
- Such systems have experimentally exhibited the following features:**
 - Digital super-resolution**
 - Depth of field extension**
 - Logarithmic dynamic range adjustment**
 - Multispectral**
 - Low aspect ratio (slim form factors)**
 - Polarimetric**
 - Wide FOV**

¹**Purposeful sensing:** application-specific sampling with optimal allocation between space, intensity, spectrum...



Oldest Computational Imaging Sensor: Michelson Stellar Interferometer

A. A. Michelson, "Visibility of Interference-Fringes in the Focus of a Telescope,"
Phil. Mag. 31, 256-259 (March 1891).

Astronomical Society of the Pacific

217

VISIBILITY OF INTERFERENCE-FRINGES IN THE
FOCUS OF A TELESCOPE.*

By ALBERT A. MICHELSON.

When the angle subtended by an object viewed through a telescope is less than that subtended by a light-wave at a distance equal to the diameter of the objective, the form of the object can no longer be inferred from that of the image. Thus, if the object be a disk, a triangle, a point, or a double star, the appearance in the telescope is nearly the same.

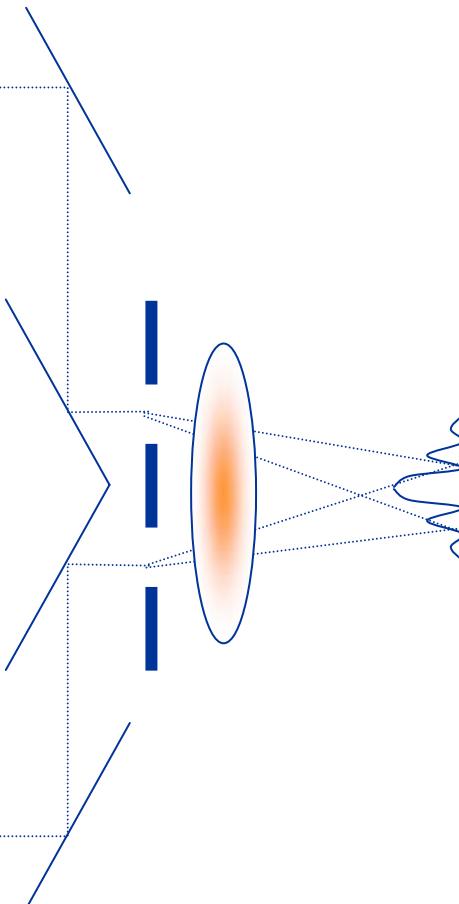
If, however, the objective is limited by a rectangular slit, or, better, by two such, equal and parallel, then, as has been shown in a former paper,† the visibility of the interference-fringes is, in general, a periodic function of the ratio of a , the angular magnitude of the source in the direction perpendicular to the length of the slits, and a_0 , the "limit of resolution." The period of this function, and thence $\frac{a}{a_0}$, may be found with great accuracy; so that by annulling the greater portion of the objective the accuracy of measurement of the angular magnitude of a small or distant source may be increased from ten to fifty times. As ordinarily understood, this increase of "accuracy" would be at the cost of "definition" (which, in this sense, is practically zero); but if by "definition" we mean, not the closeness of the resemblance of the image to the object, but the accuracy with which the form may be inferred, then definition and accuracy are increased in about the same proportion.

In almost every case likely to arise in practice, the form of the source is a circular disk; and if the illumination over its surface were uniform, the only problem to be solved would be the measurement of its diameter. But in many cases the distribution is anything but uniform. If the curve representing the distribution along the radius be $i = \psi(r)$, then the element of intensity of a strip $y_i dx$ will be

$$\int_{-y_i}^{y_i} \psi(r) dy = \phi(x),$$

* Reprinted, by request, from the *Philosophical Magazine*.

† "On the Application of Interference Methods to Astronomical Measurements" (Phil. Mag., July, 1890).



Automotive Analogy for Imaging Sensors



Horse-drawn Carriage

Horse-*less* Carriage



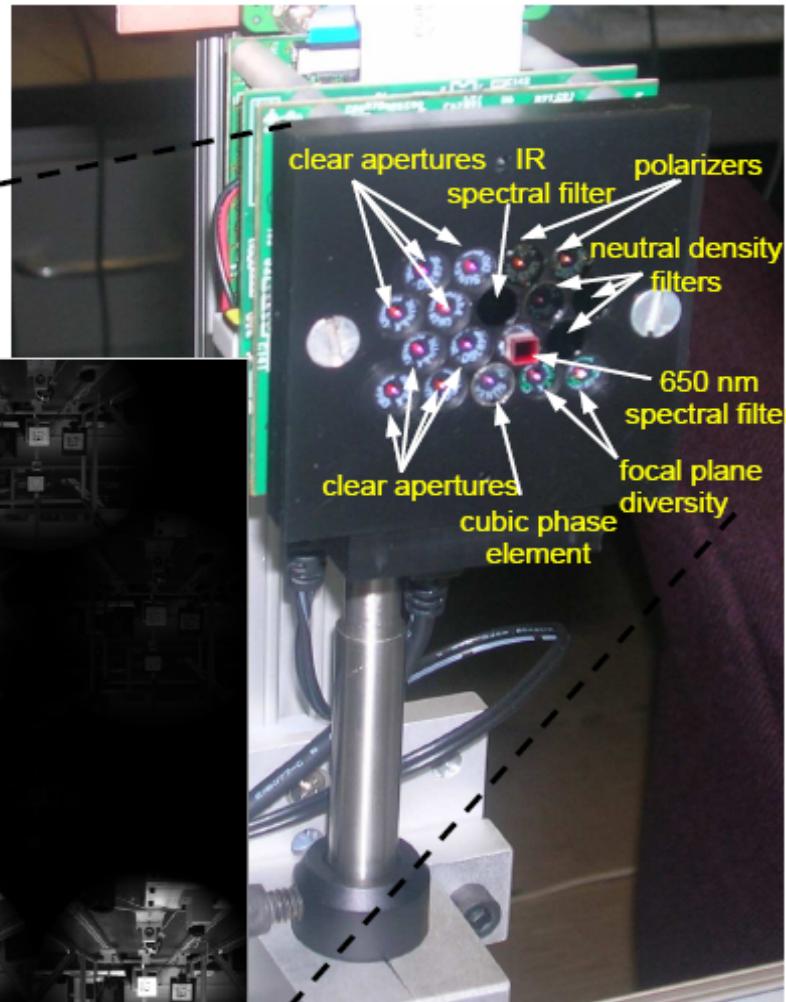
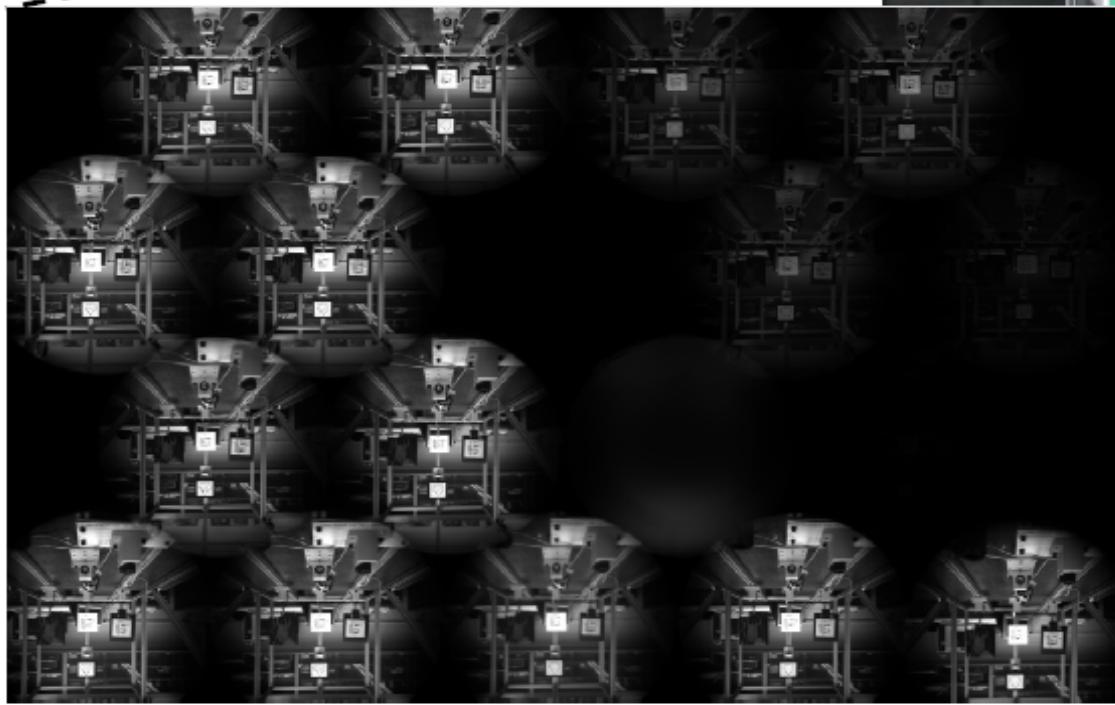
Specialization?
Autonomy?

Film Cameras

Film-*less* Cameras

Multi-Aperture, Multi-Diversity Compact Imager: PERIODIC Seedling

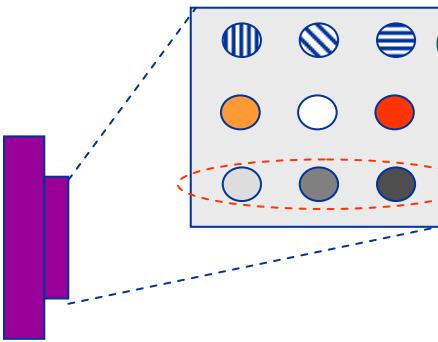
Full 10.8 MPixel Image



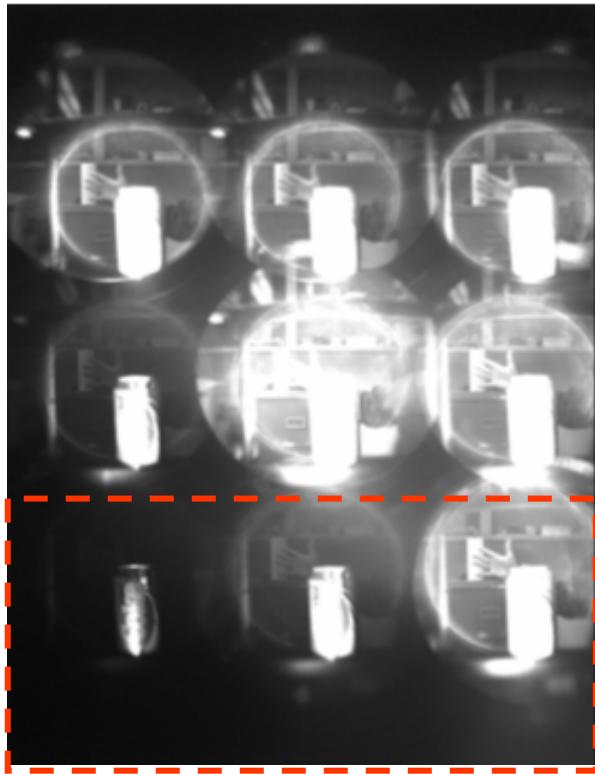


PERIODIC Demonstration

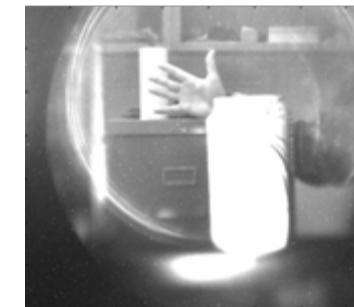
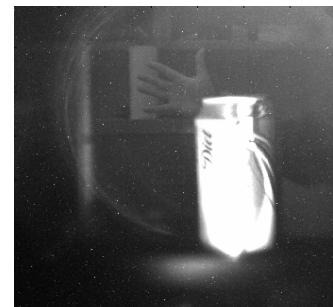
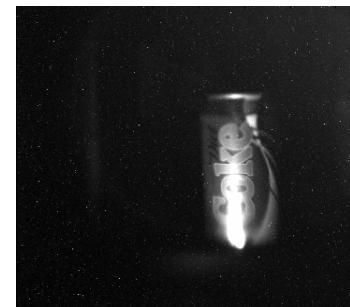
Compound Eye Camera



Three neutral
density
filters.

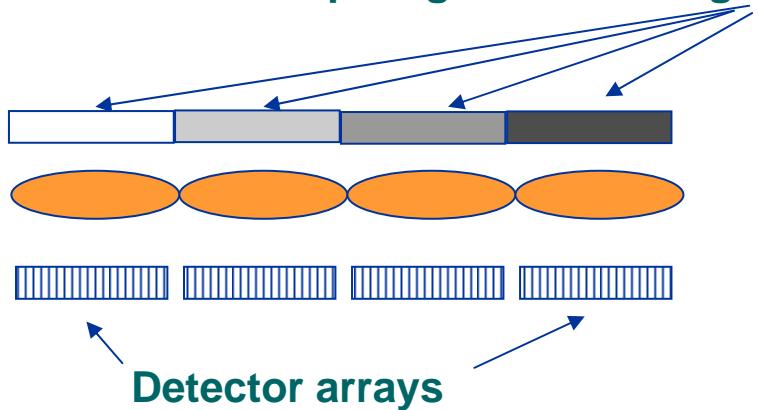


Combining
subimages using
three different
neutral density
filters can be used
to improve dynamic
range



Imaging of High Dynamic Range Scenes – Conventional vs. PERIODIC

Simple light attenuating filters



- Place different neutral density filters in different 'subimagers.'
- Capture image
- Perform image computation

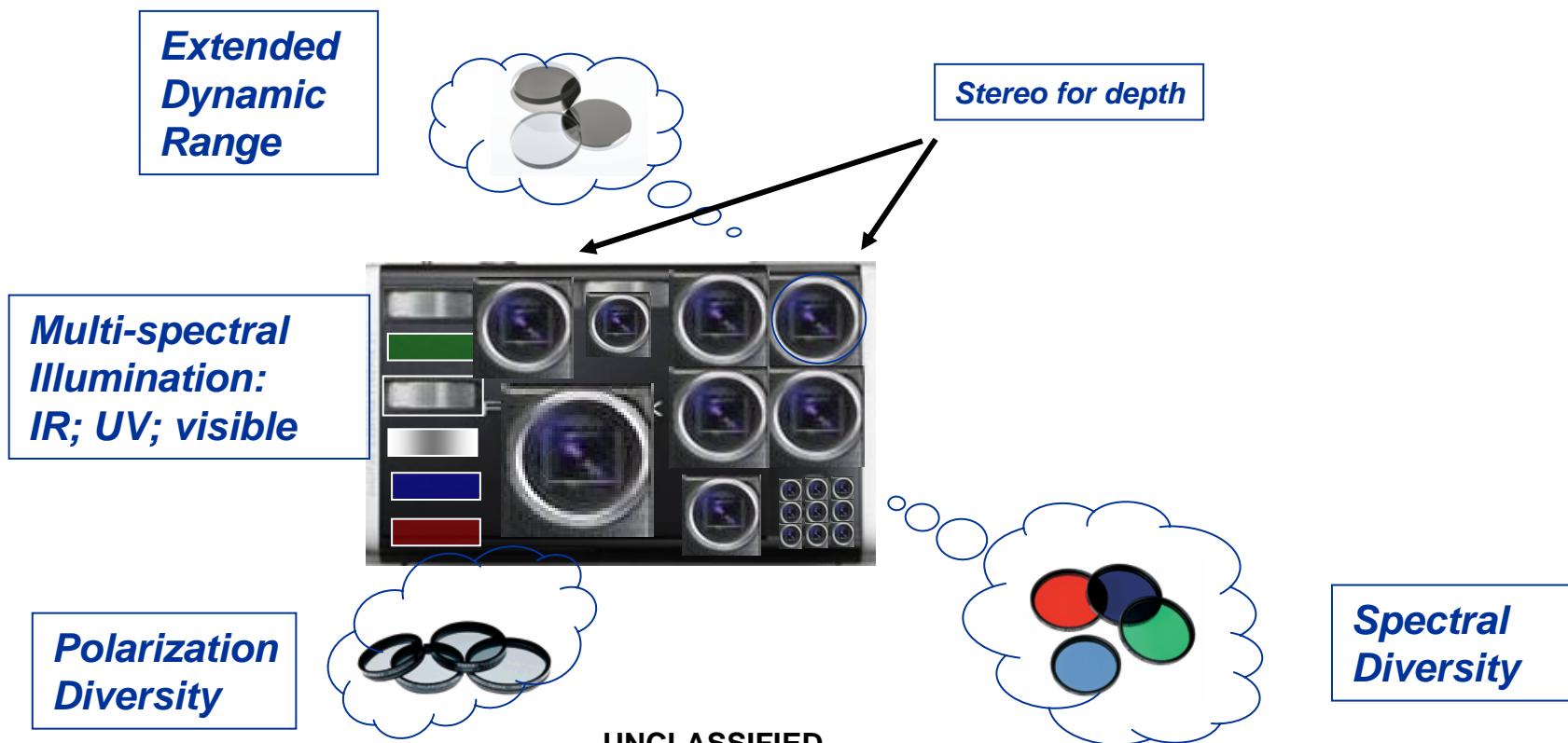


Short exposure time needed
 to see details in bright
 regions
 Some portions of scene underexposed
 Rest of scene overexposed
 Rest of scene underexposed

Next Generation System CONOPS

The “Swiss Army” Imaging System

- Multi-aperture architecture with **dynamic** diversity elements
- Multi-spectral, broad-band sensing (visible-LWIR)
- Multi-band illumination for chem-bio sensing
- Optimized Integration with post-processing and display
- Ultra-thin aspect ratio





Computational Imaging Systems =

Nanophotonics + Megapixels + Gigaflops + Form Factor + Power

Jointly designed and optimized

Mission Goal:

Purposeful, Semi to Fully Autonomous Sensing



Thank you

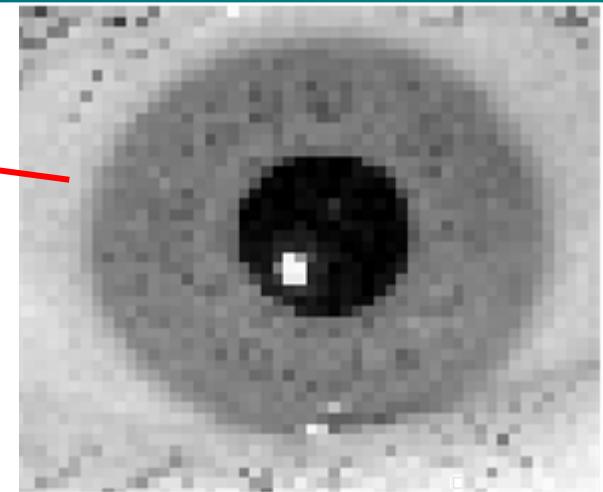
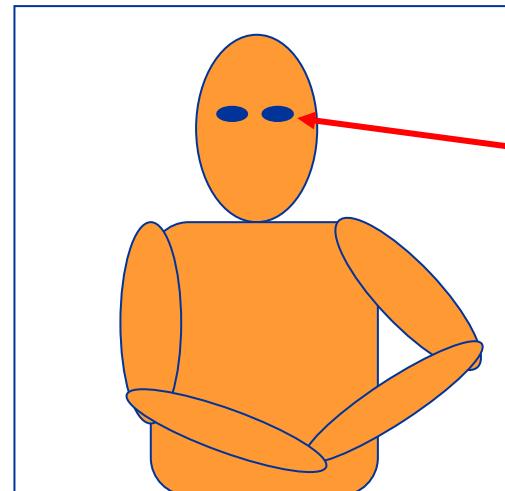
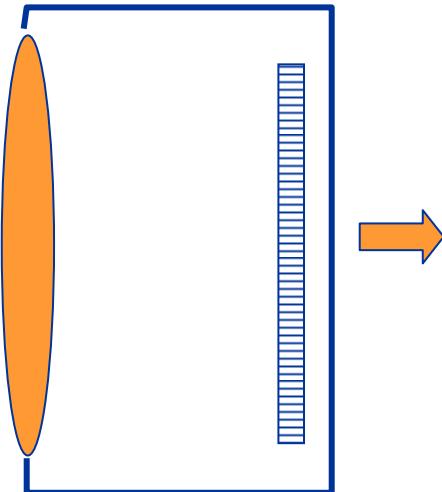




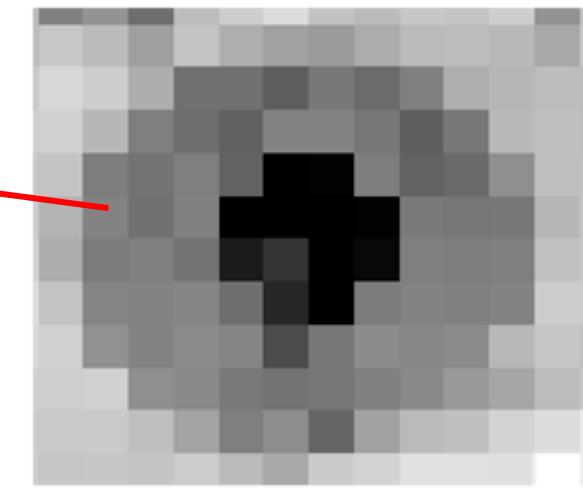
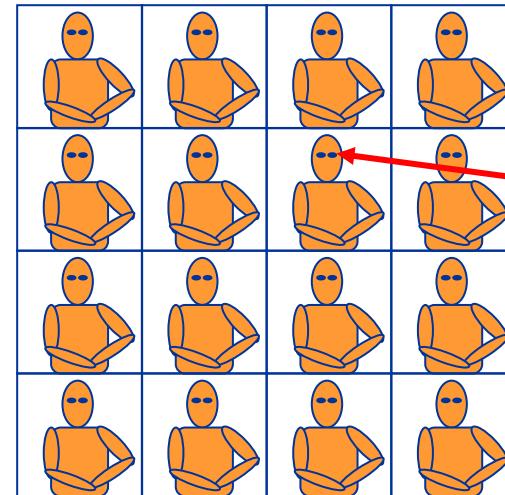
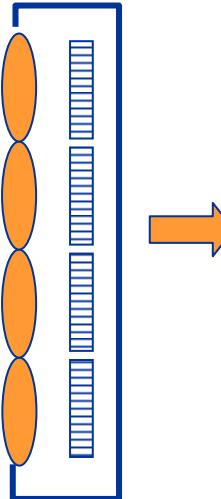
BACKUP

Form Factor Reduction

Standard system



PERIODIC system



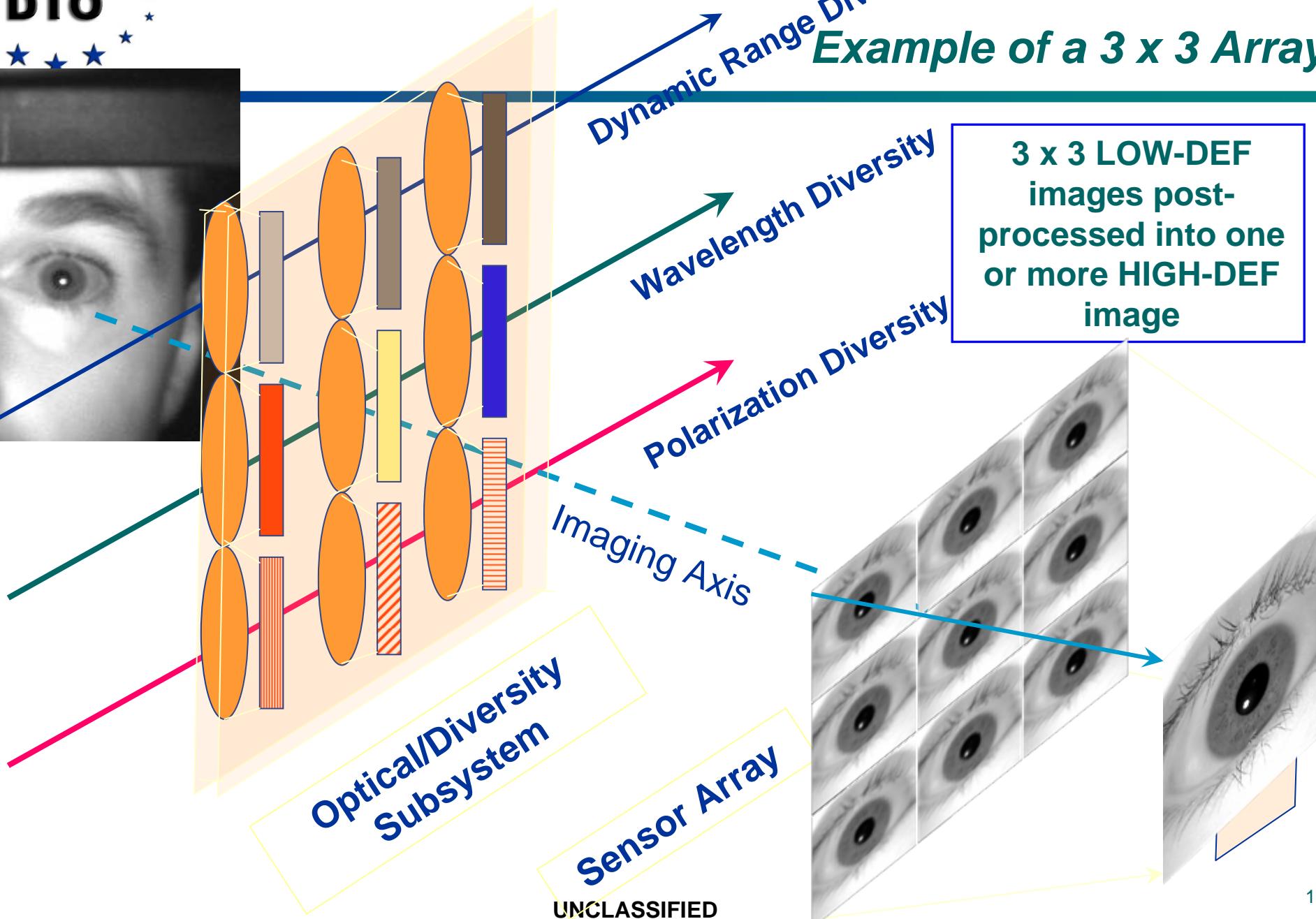
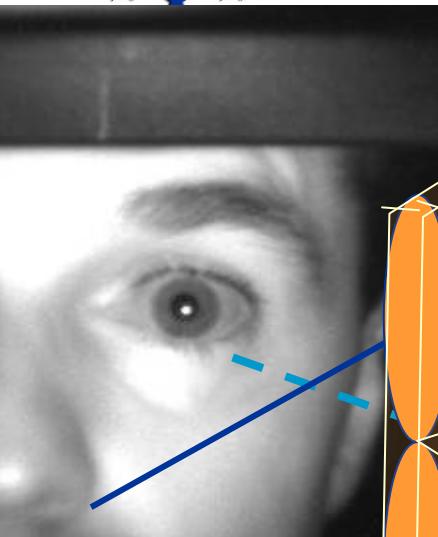
If the images are acquired such that they are shifted with respect to each other by subpixel amounts, the full resolution image can be restored subject to noise and other uncertainties.



UNCLASSIFIED

Dynamic Range Diversity

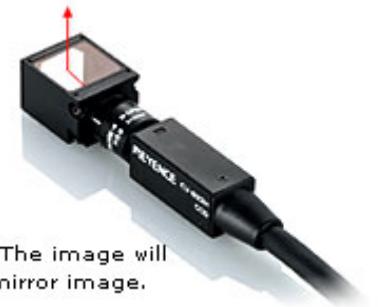
Example of a 3×3 Array



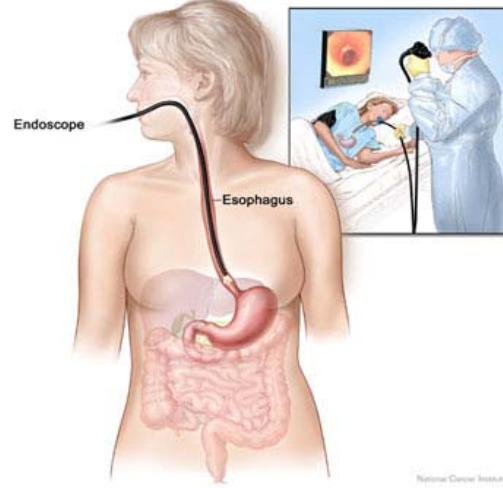


Digital Cameras....all shapes and forms!

But they all operate the same way



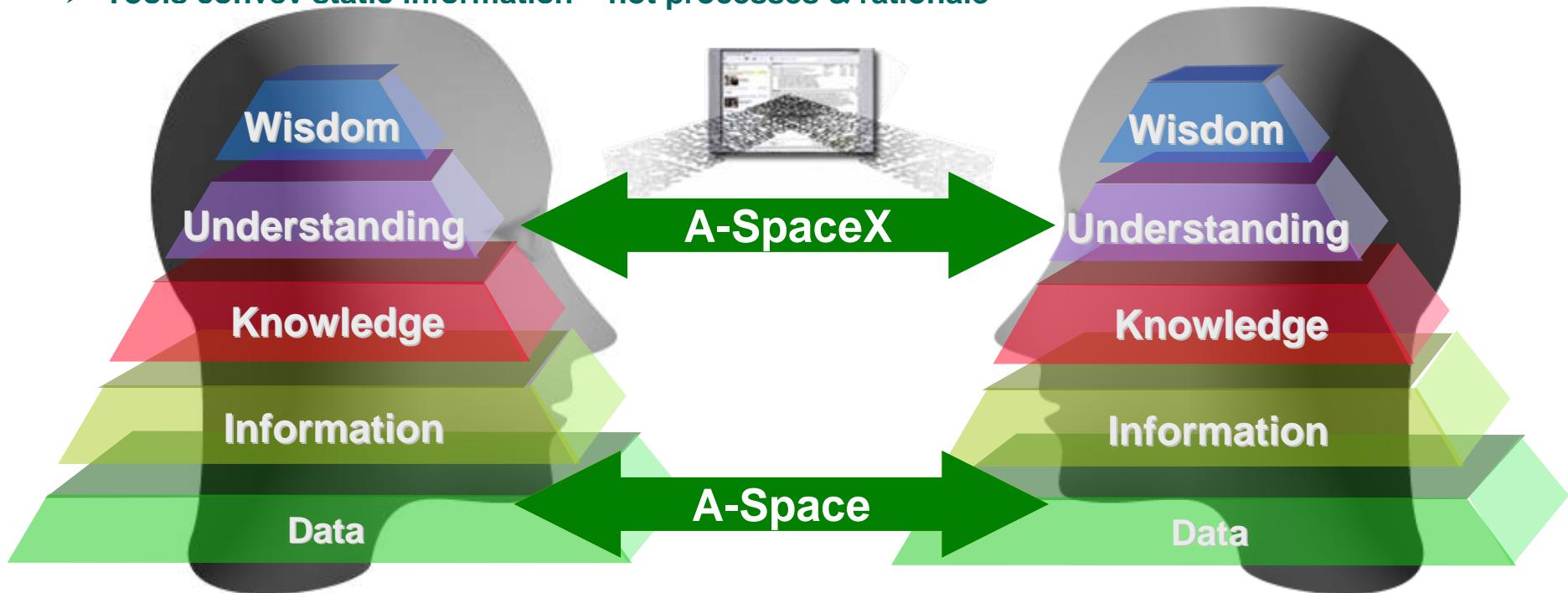
Note: The image will
be a mirror image.



MMP Collaborative, Multi-INT Systems

Operational Problems

- ❑ Too much data – not enough information!
 - Multiple, poorly defined threats make it hard to know what is salient.
- ❑ Conventional visualizations do not readily support analytic processes
 - Decision making highly branched & iterative characteristic of analytic processes
 - Hypotheses abandoned today may be salient tomorrow
 - Context is key to framing and understanding the problem –
- ❑ Sharing is hard – Understanding is collective!
 - Sharing uncertainty is at odds with IC culture
 - Tools convey static information – not processes & rationale





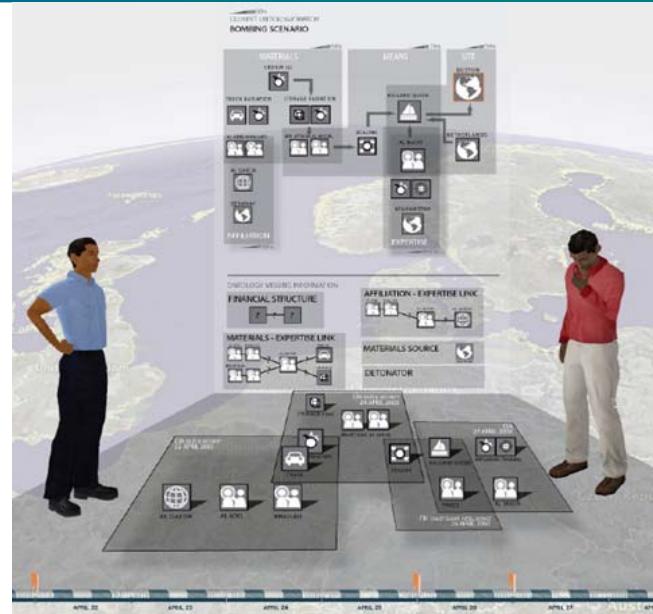
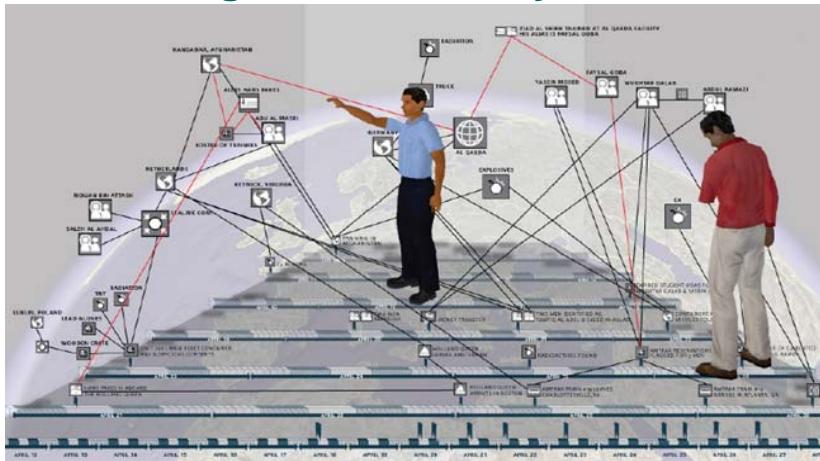
Opportunities

Web-enabled Technologies

- Modern & next generation browsers support advanced visualizations
- Web technologies consistent with Services Oriented Architecture (SOA)
- Multiple Visualizations readily derived from shared data sources

MMRPG technology viable

- Readily available
- Next-generation analysts are comfortable



Models maturing

- Models as games,
- Models as processes
- Products inter-operable

Agent Technologies & Automation

IC is making major commitments to upgrade infrastructure. (A-Space)

A-SpaceX has a unique opportunity to impact the future of the IC!

Example Environment



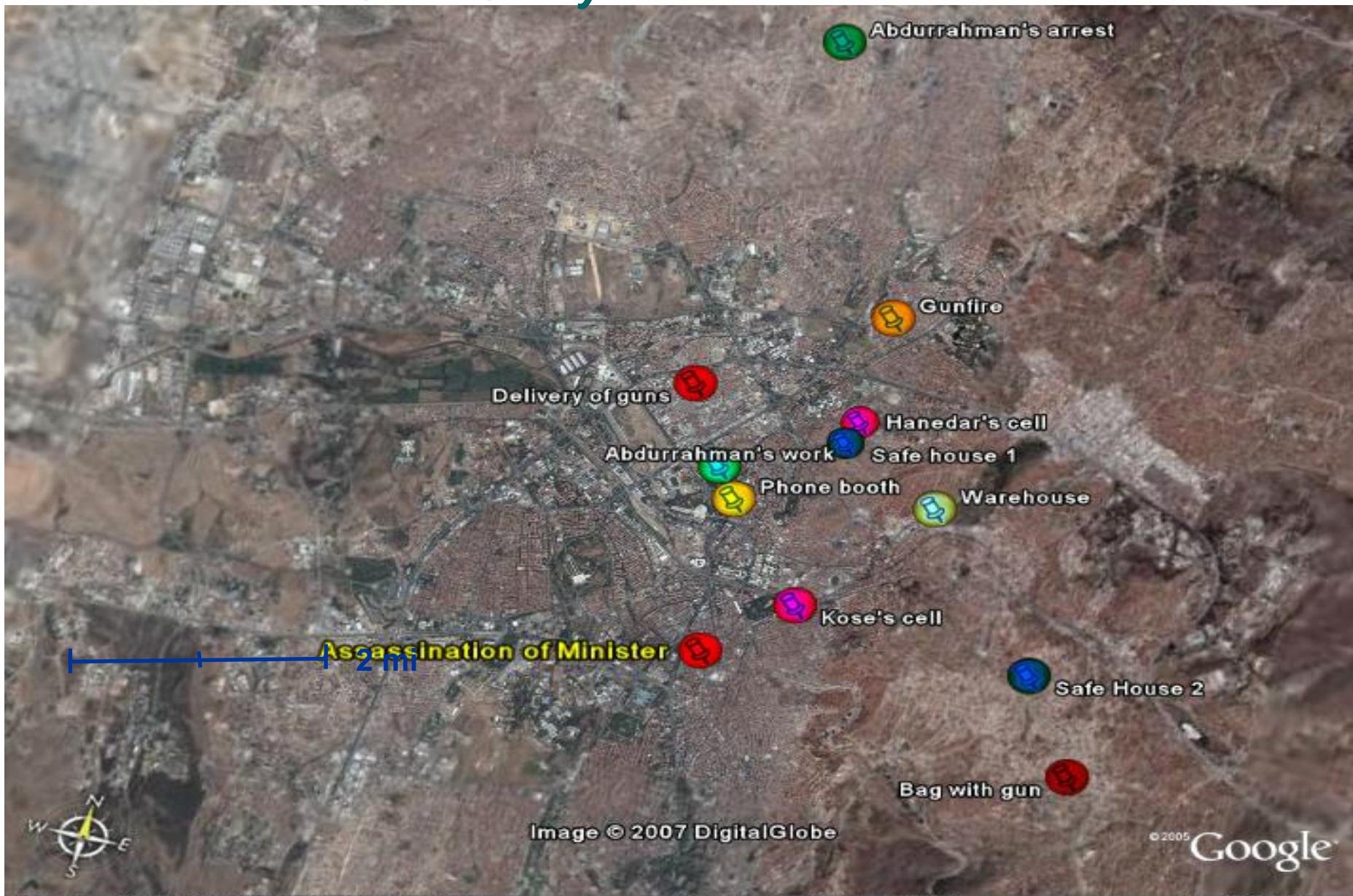
Geospatial Profiling for Counter-Terrorism



UNCLASSIFIED

Geospatial Profiling for Counter-Terrorism

Case Study: Assassination of Turkish Minister



UNCLASSIFIED

Proactive Intelligence Analysis



Why Proactive Intelligence (PAINT)?



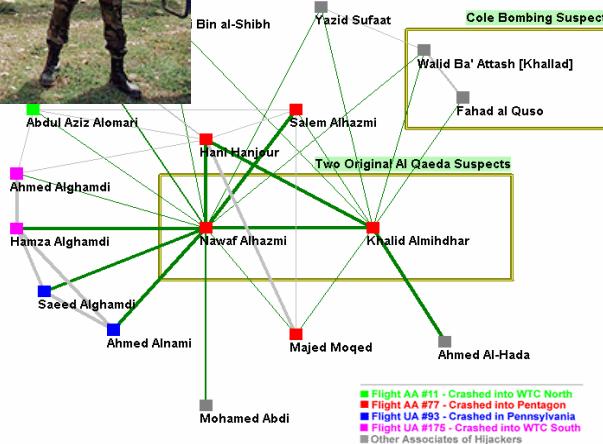
Cyber attack

Weeks to recover



Bioterrorism

Pandemic in days



Terrorism Attack

Disruptive Change



Smallpox attack exercise without proactive warning or plans has dire consequences

- Rotterdam port, world's 2nd largest, closes
- Polish citizens stream to Germany for scarce vaccine
- Debate on closing borders, quarantining cities, and limiting the movement of people
- World Health Organization lacks authority



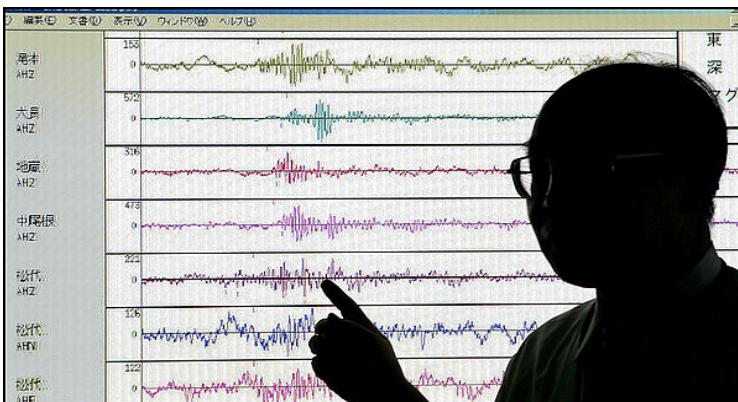
□ Project Forward



Doomsday Clock moves closer to midnight by two minutes due to nuclear weapons programs in Iran and North Korea.

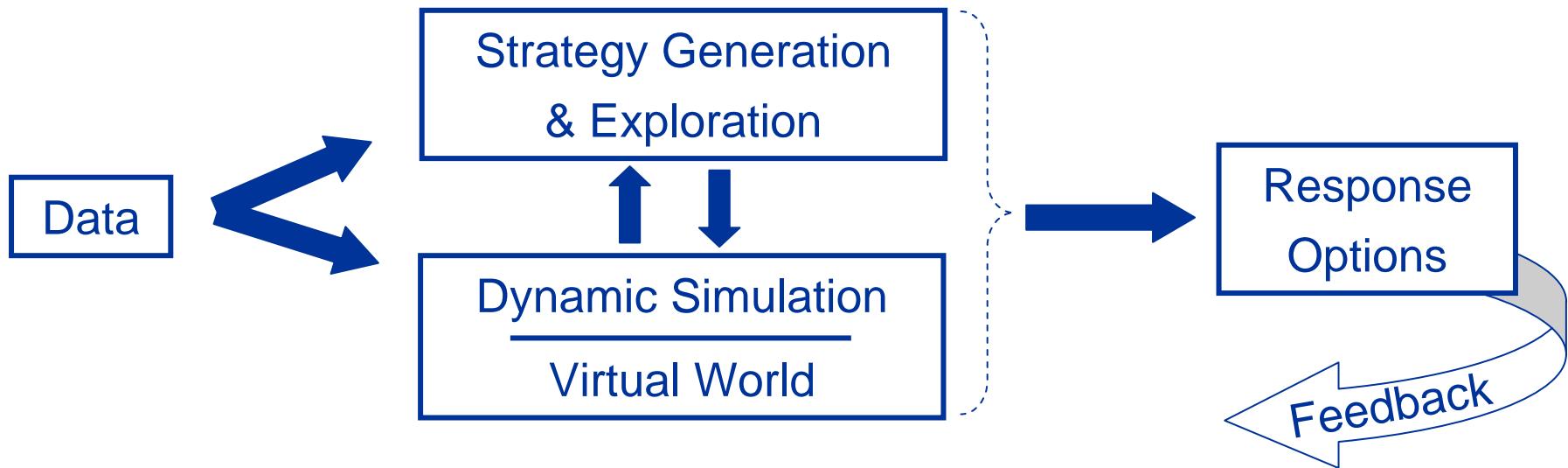
-February 25, 2007, Board of Directors of the *Bulletin of the Atomic Scientists*

- Explore strategies & identify response points



- Monitor test areas
- Disrupt supply chain
- UN trade ban re uranium enrichment
- UN diplomatic & economic incentives
- US financial sanctions

What's New in PAINT's Approach?



Near-term

Timely: Rapid ID of causal relationships in diverse data sets

Mid-term

Adaptive: Construct models to handle sparse & ambiguous data

Semi-autonomous: cultural, environmental & threat models formulated with “light touch”

Integrated: Strategy tests with dynamic simulations & virtual worlds

Goal

Project future threat developments and identify response options



Strategic Challenges in the Asia-Pacific Region

*Three Waves of Five...&
Some Trends Ahead*

LTG (Ret) Ed Smith
Director, APCSS



With us now:

1. The attraction of terrorism to those disadvantaged and with little hope.
 - An opportunity for identity; a means to act
 - Enablers:
 - Socio-economic gaps
 - Transnational crime
 - Globalization (seamless internet effectiveness)



With us now:

2. The limiting effect of corruption,
particularly within governments,
throughout the region and the world.

- Pervasive
- Enervating
- Tolerated, too often by many



With us now:

3. Political polarization leading to extremist views...AND diminishing shared values.

- Interest → Identity → Values clashes
- Strategic alignments—major actors
 - PRC-Russian security cooperation
 - PRC-South Asian nations
 - Entire region positioning, given PRC economy
 - US presence, a security ctr-weight



With us now:

4. Disrespect due to a lack of appreciation for cultural/racial/ethnic diversity.

- Rooted in intellectual, ethnic, racial, social, & psychological arrogance
- Fundamental to collaborative progress
- Ldr-to-ldr relationships “decide the day”



With us now:

5. Extremes in educational opportunities.

- Deeds, not words
 - Availability
 - Quality
 - Access
- Why not main effort collaborative prioritization?



With us now, or ...on the horizon:

1. Extremes in human security due to the growing have and have-not gaps the world over.

- Demographic profiles identify possible security threats
- Socio-economic trends are key



With us now, or ...on the horizon:

2. Interruptions in information-technology networks that impact global security.
- Info-age absolute dependence on IT, especially in the economic and military dimensions.
- Are “degraded-mode” operations still an alternative?
 - F-22s
 - World financial systems



With us now, or ...on the horizon:

3. Environmental effects

physically impacting large portions of the region/world due to unchecked global warming.

- Fact: global economic competition driving adverse environmental impacts
- Energy security gained using less environmentally threatening energy sources



With us now, or ...on the horizon:

4. Over-extension of multinational and multilateral forums intended to foster collaboration on security-cooperation opportunities.

- UN simultaneously in crisis & demand
- Many international orgs face calls for reform (UN, WTO, IMF)
- Shaping potential of Asia-Pacific forums...impacts?



With us now, or ...on the horizon:

5. Uncontrolled means of mass destruction and/or mass chaos.

- Unraveling global nonproliferation
- Nuclear wpns: security asset or liability?
- Shock event → Chaos, in info age
 - Dirty bomb, or atk on nuclear reactor
 - Low-tech tactics also show potential



With us now, or on the horizon, ... but translucent

1. Conflict over scarce and valuable resources and/or disputed territory believed to contain such resources.

- For example, potable water in South Asia...or anywhere else



With us now, or on the horizon, ... but translucent

2. Balancing country X's demand for increased power and influence and the willingness of other major actors to accommodate this.

- PRC
- India
- Smaller countries on the rise (Vietnam)



With us now, or on the horizon, ... but translucent

3. Mutating pandemic disease
among humans.

- “One in ten chance of human-to-human transmission in next ten yrs.”
- World health orgs not as confident
 - Not “if” but “when”
- What type, where, by whom, & how much prep is enough?



With us now, or on the horizon, ... but translucent

4. Understanding, and managing, reactions to the perceived threat of information globalization to cultural identity.

- Pursued “inside out”
- Grounded in promise, not fear
- Transforming from power to coerce to power to aid



With us now,
or on the horizon, ...
but translucent

5. Leaders without a vision that serves the common good...the harder right.
- How do we develop ldrs with such vision?



So What?

- If these are trends, how do we influence and shape them, to advantage? Or, mitigate those we cannot shape?

A couple final thoughts...



Final Thoughts

- Security challenges have always been complex, but perhaps the nature of the complexity today is shifting
- **Ways** (problem analysis), toward solutions, require “centering” highly dynamic, diverse knowledge/people relationships and their impacts on organizational potential
- **Means** must be adapted to applications in very different social & cultural frameworks
- **Ends** sought → conditions v. endstates

KNOWLEDGE DISCOVERY

From Situational Awareness to Bomb Damage Assessment

LTG (Ret) George A. Fisher
Oak Ridge National Laboratory

“Connecting the Dots”



**“All I’m saying
is, now is the
time to develop
the technology
to deflect an
asteroid.”**

A Couple of Facts

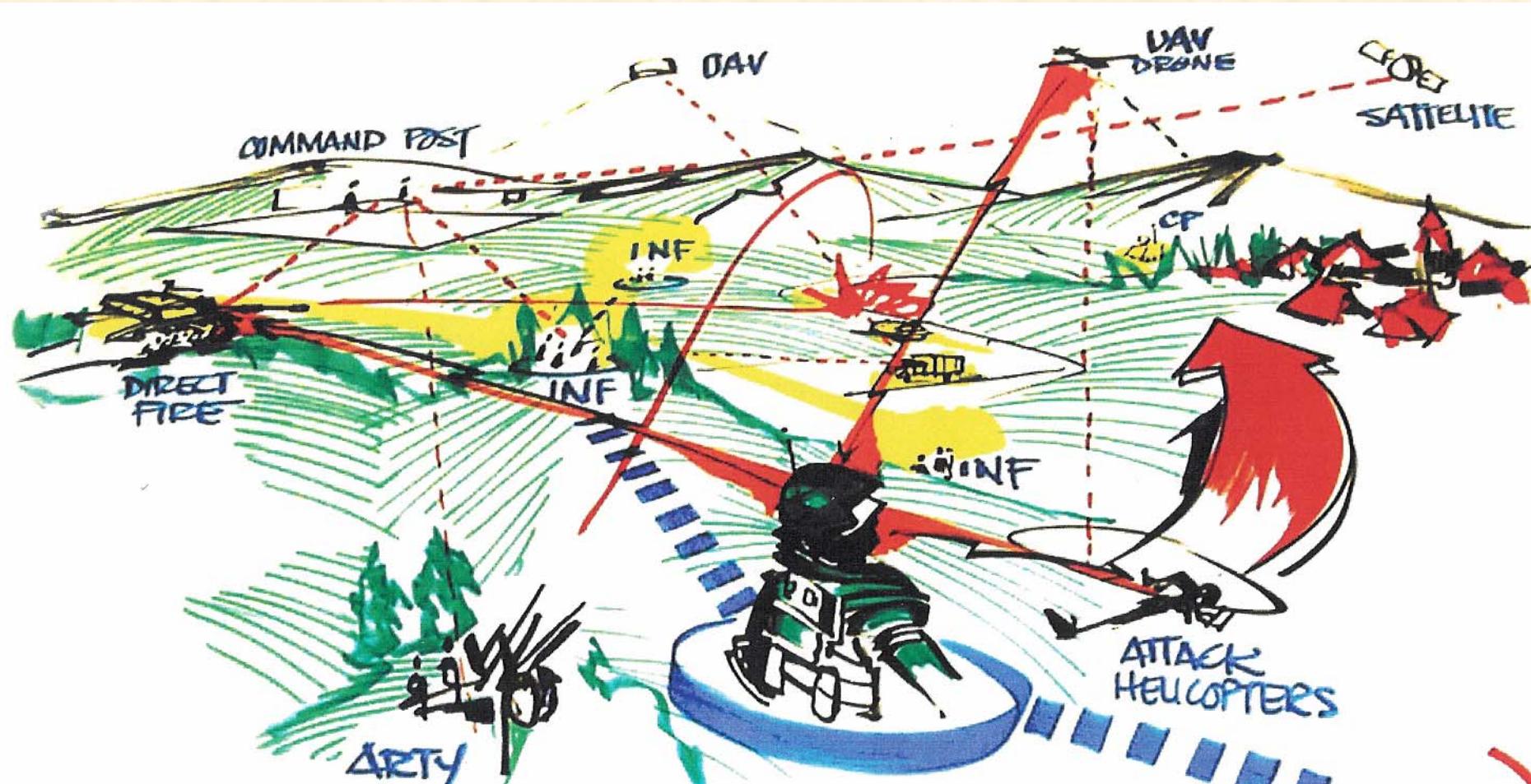
The Brigade Combat Team of 2015 can expect 3,178,800 sensor reports per hour in its area of operations

~~Client Server~~

In 2006, the amount of digital information created was 3 million times all the books ever written

~~Manual~~

THE 2020 War Fighter



“Know what the Network Knows”

Challenge – What to do with this?



- **What is in there?**
- **Are there any threats?**
- **What am I missing?**

Connecting the Dots

Raw Documents

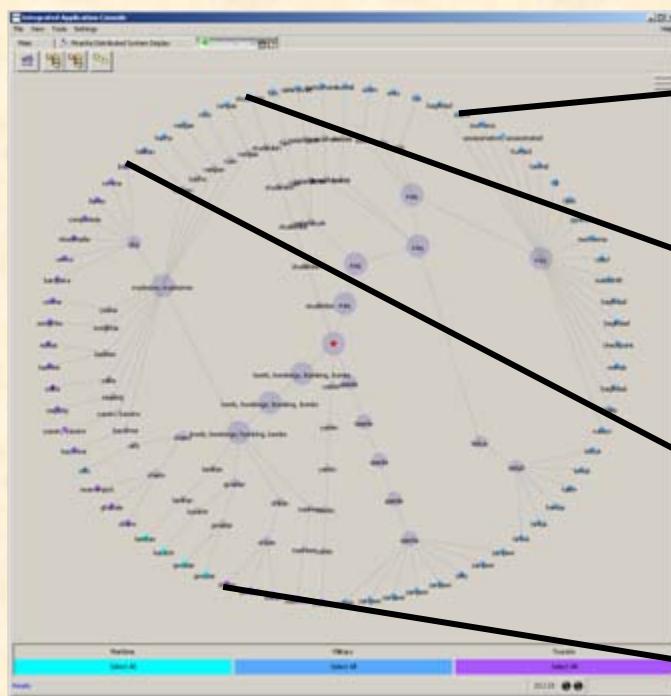


Organize the Information



What do we have?

Connect the Information



What are the connections?

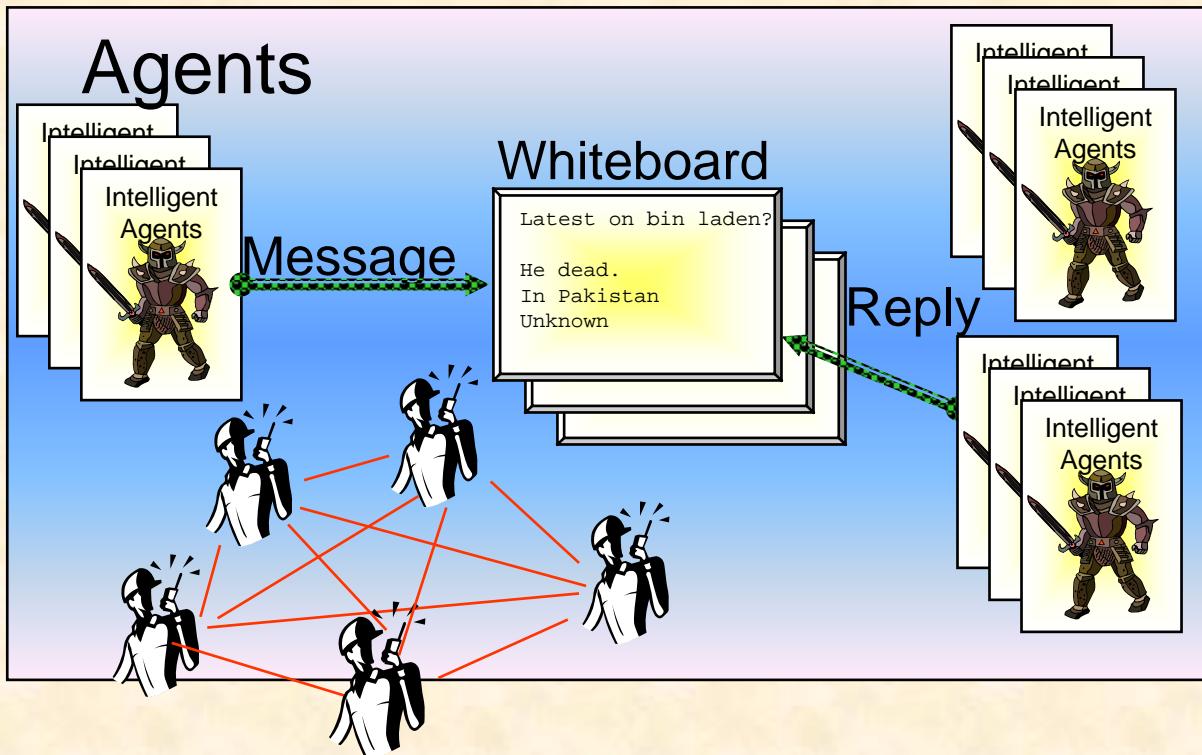
Find the Threats



Take Action



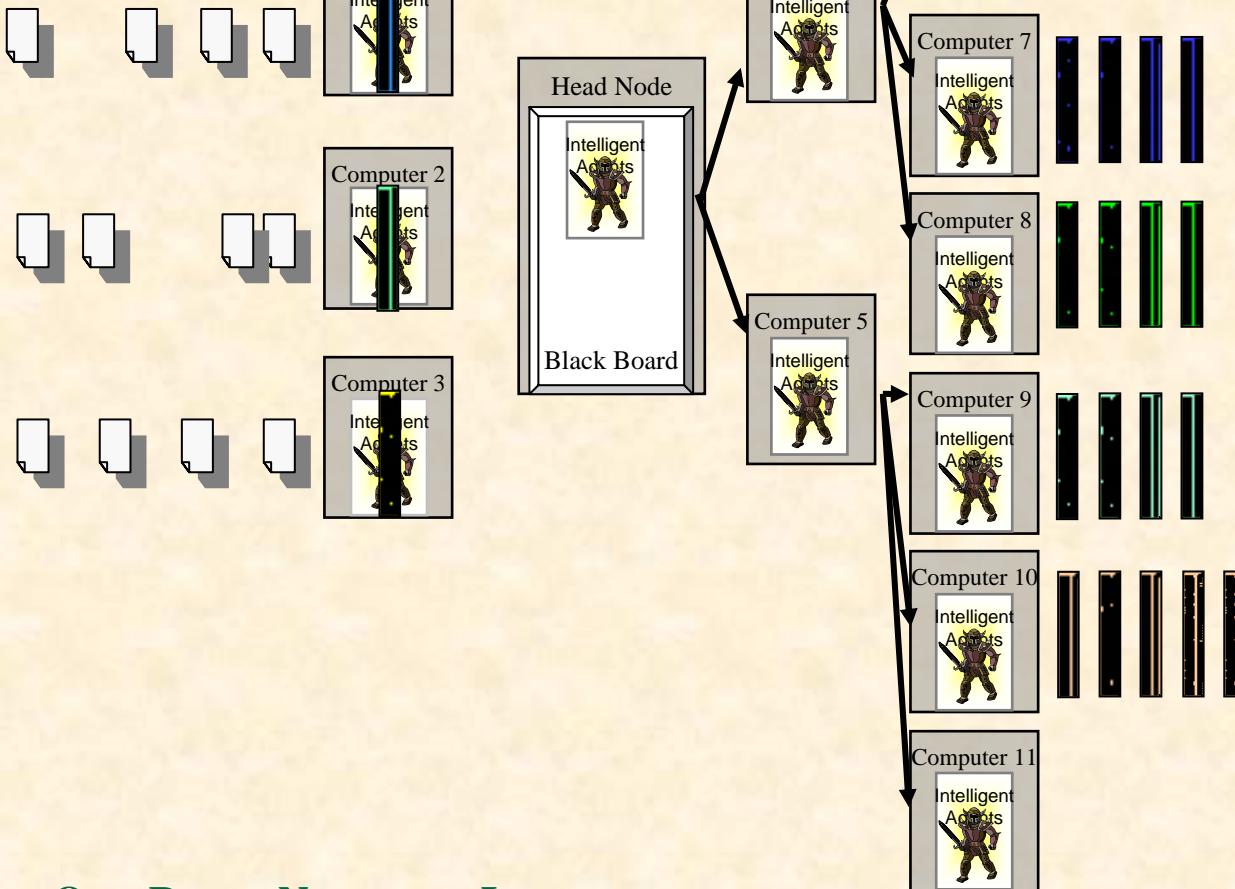
Intelligent Software



- **Intelligent Agents**

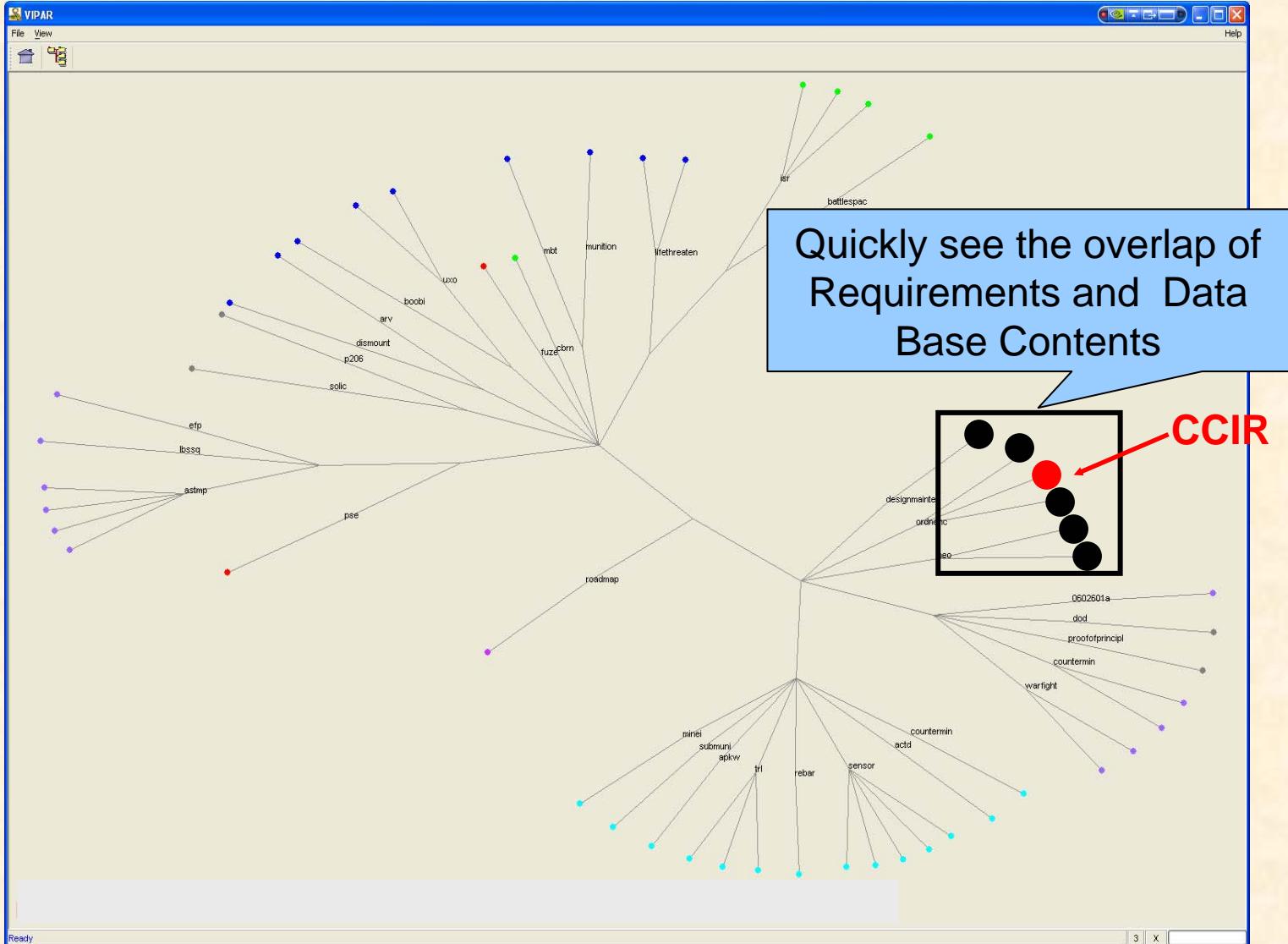
- Software processes
- Can communicate in unstable environments
- Form teams to solve problems
- Live, die, and reproduce to solve problems

Agent Approach

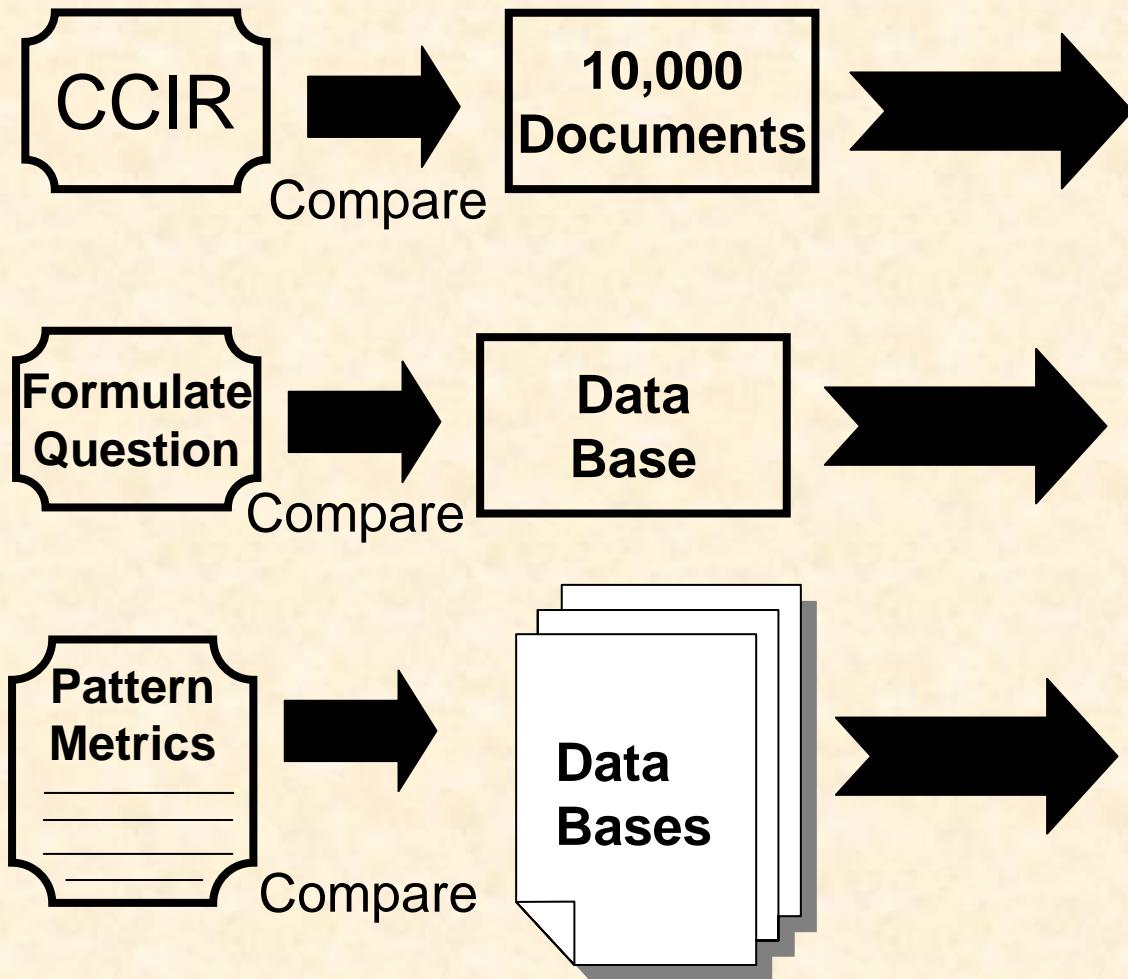


- Standard Approach
11.5 Days
- Agent approach
8 minutes 24 Seconds!
2000 times faster
With no loss of accuracy

Results



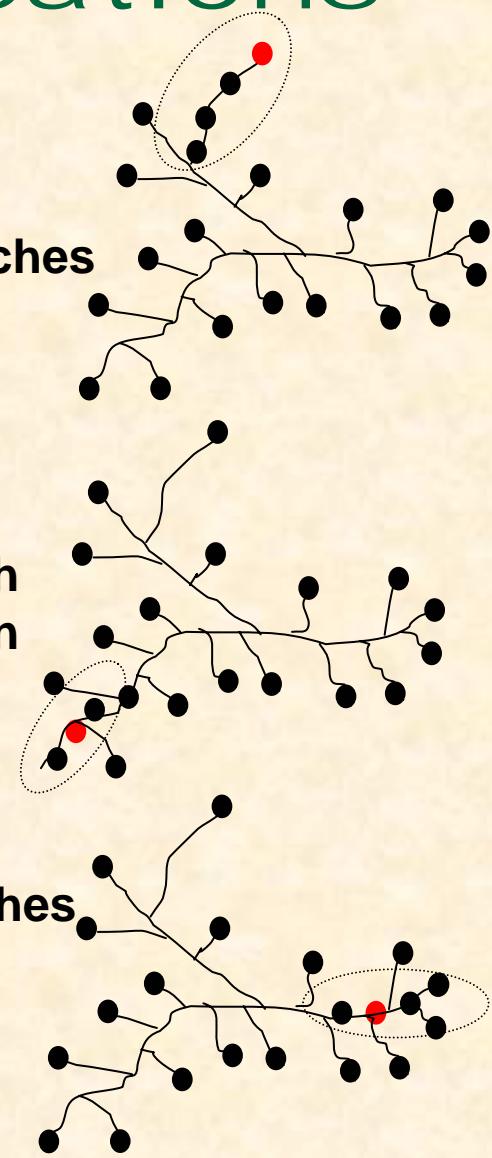
Software Agent Applications



Best matches
to CCIR

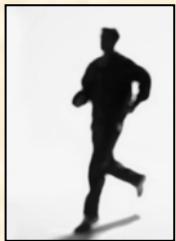
Best match
to question

Best matches
to pattern



Next Step: Adding DNA to Agents

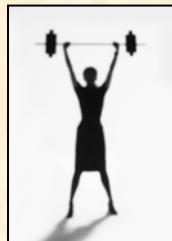
Endurance Speed



Agility



Strength



Group



Method



Target



Location



Speed/Strength



Group/Method



Target/Location



Group/Method/Target/Location



Connecting the Dots

Threats

6 Indonesians Barred From U.S.
Current and Former Military Officers

Play
By
War
Fri
The
dozen current
officers, includ
on a watch list
barring them from entering the United States,
according to U.S. government officials.



Slevin
ters



Cold war leaves a deadly anthrax legacy



Miller



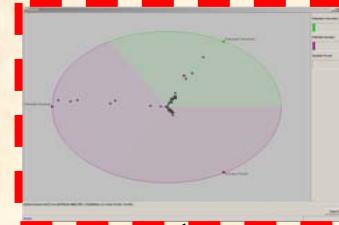
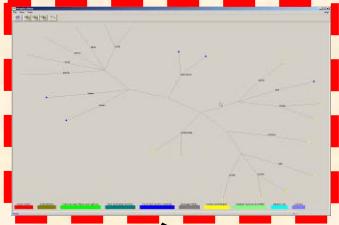
VOZROZHDENIYA ISLAND, Uzbekistan -- In the spring of 1988, germ scientists 850 miles east of Moscow were ordered to undertake their most critical mission.

Agents

OSCAR High Performance Computer Cluster



Analysis



Decision



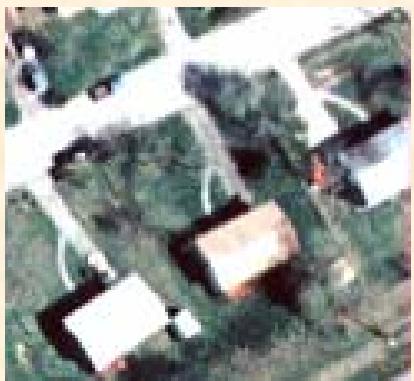
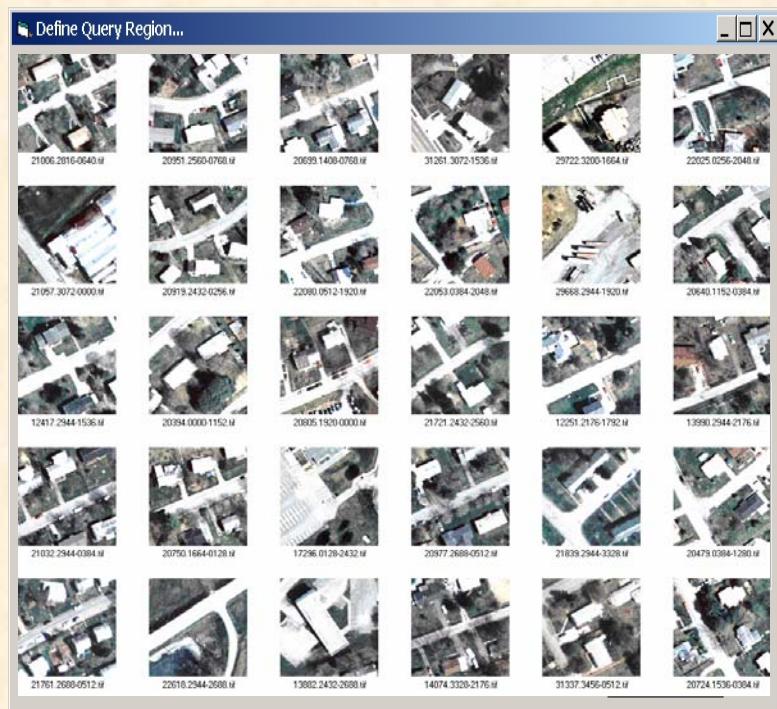
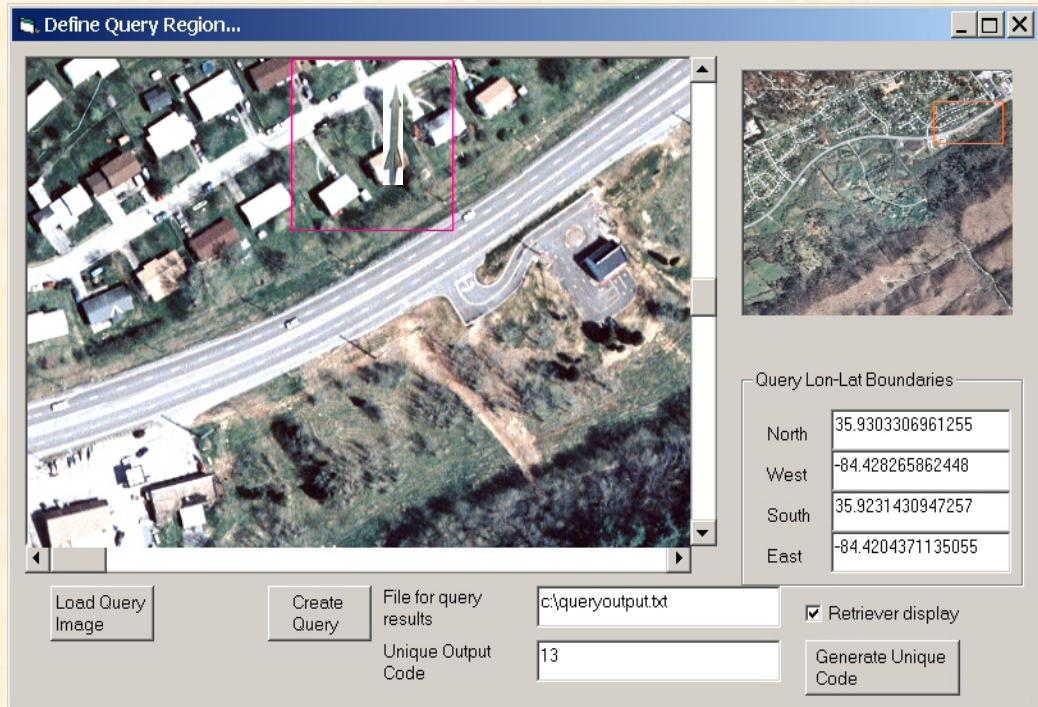
Synthesizing and
Disseminating
Information

Screen Satellite Photos at Machine Speed

- Is your image repository up-to-date and accurate?
- How can you search through thousands of images in seconds?
- How can you comprehensively search based on:
 - Longitude and Latitude
 - Box on a map
 - Time
 - “Just like this one”



Find "Just like this one..."



Where is
the
missile ?

Cyber Security

Relate Sensitive Research to IP addresses

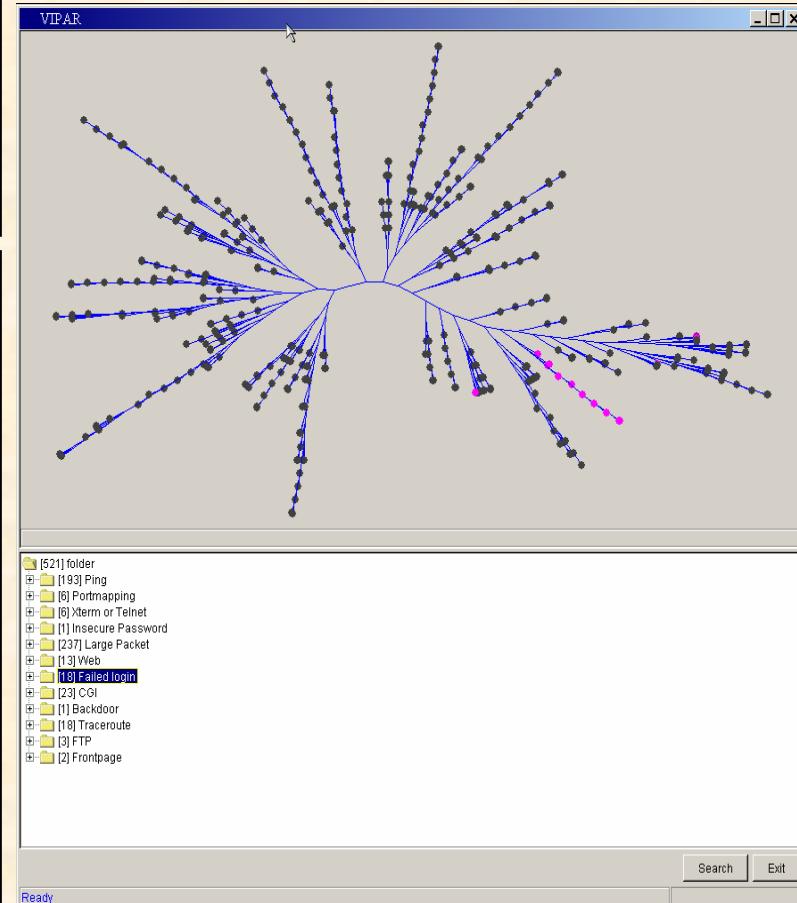
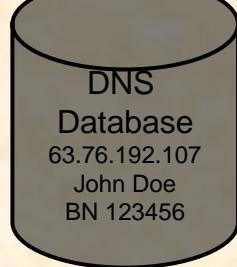
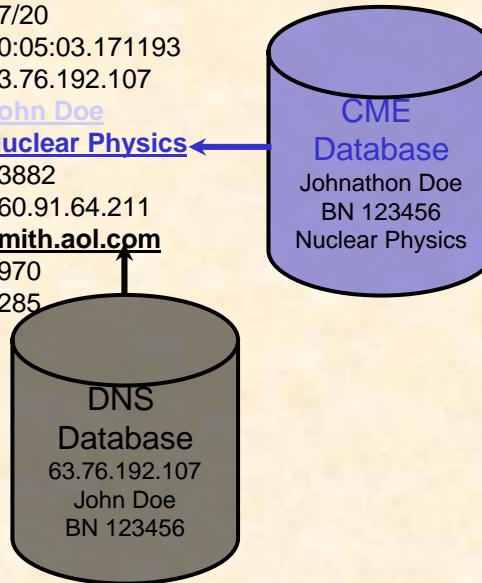
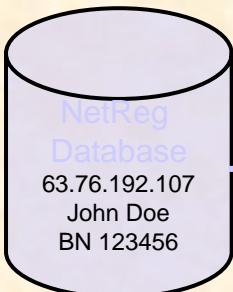
- 1,000,000 suspicious records daily

- Critical Decisions

- Is someone trying to hack into the system?
- Are attack from “script kiddies” or state sponsored?
- What are they going after and why?

Activity Log Entry

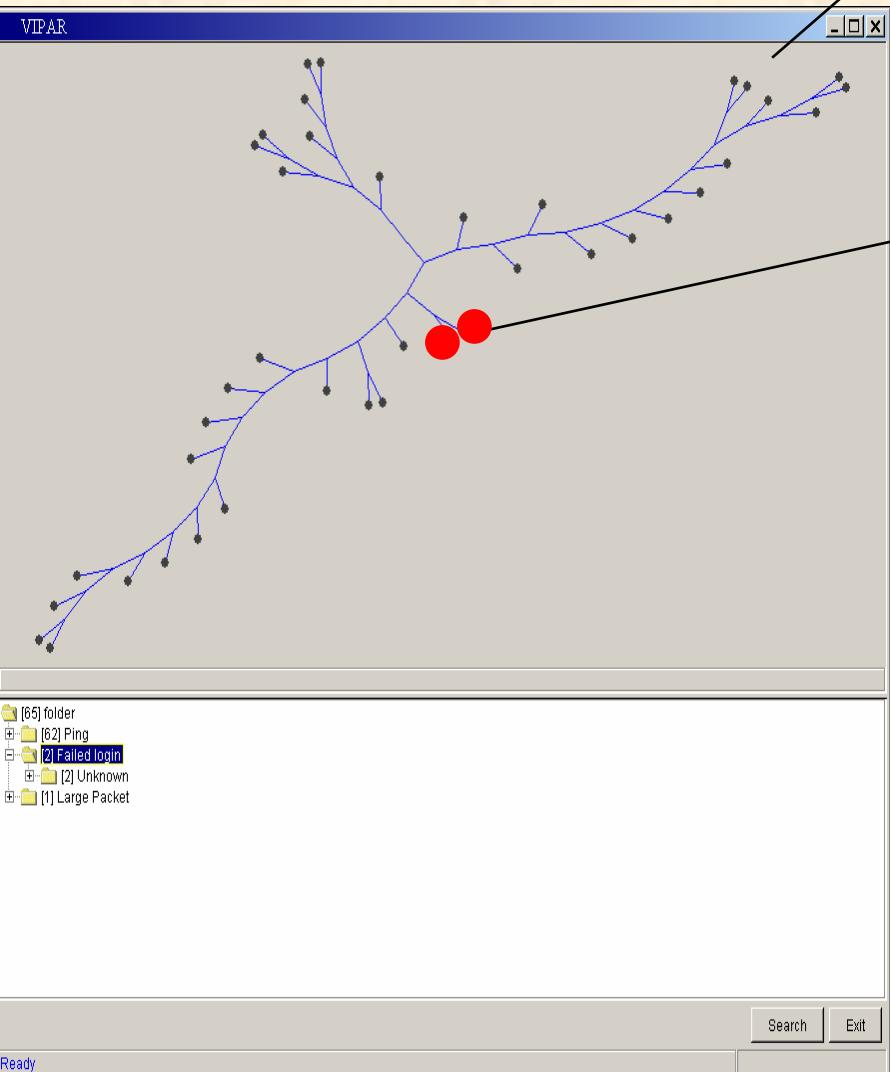
Filter: misc-000264 IDS247 - MISC - Large UDP Packet
Date: 07/20
TOD: 00:05:03.171193
Source IP: 63.76.192.107
User John Doe
Research Area Nuclear Physics
Source Port: 23882
Target IP: 160.91.64.211
Target Name: smith.aol.com
Target Port: 6970
Length: 1285



Caught in 30 Minutes!

45 “low and slow” pings from:

- Country X
- Country Y
- Country Z



2 attacks on nanotechnology scientists

Source IP: 200.10.225.87 ncache07.terra.cl

| Date | Time | Source Port | Destination IP | Destination Hostname | PI Name | Research Area | Destination Port | Length | Filter |
|-------|-------|-------------|----------------|----------------------|---------|--|------------------|--------|--|
| 07/23 | 14:14 | 80 | 128.219.49.130 | LQ32.CT.ORNL.GOV | | Chemical and Material Science on Nanostructured Surfaces: Biometric Photosyn | 4145 | 455 | beta-000014 BETA - WEB - 403 Forbidden |
| 07/23 | 14:29 | 80 | 128.219.49.130 | LQ32.CT.ORNL.GOV | | Chemical and Material Science on Nanostructured Surfaces: Biometric Photosyn | 4302 | 455 | beta-000014 BETA - WEB - 403 Forbidden |
| 07/23 | 14:58 | 80 | 128.219.49.130 | LQ32.CT.ORNL.GOV | | Chemical and Material Science on Nanostructured Surfaces: Biometric Photosyn | 4654 | 455 | beta-000014 BETA - WEB - 403 Forbidden |
| 07/23 | 15:11 | 80 | 128.219.49.130 | LQ32.CT.ORNL.GOV | | Chemical and Material Science on Nanostructured Surfaces: Biometric Photosyn | 4768 | 455 | beta-000014 BETA - WEB - 403 Forbidden |
| 07/23 | 15:31 | 80 | 128.219.49.130 | LQ32.CT.ORNL.GOV | | Chemical and Material Science on Nanostructured Surfaces: Biometric Photosyn | 4934 | 455 | beta-000014 BETA - WEB - 403 Forbidden |
| 07/23 | 16:17 | 80 | 128.219.49.130 | LQ32.CT.ORNL.GOV | | Chemical and Material Science on Nanostructured Surfaces: Biometric Photosyn | 1789 | 455 | beta-000014 BETA - WEB - 403 Forbidden |
| 07/23 | 16:41 | 80 | 128.219.49.130 | LQ32.CT.ORNL.GOV | | Chemical and Material Science on Nanostructured Surfaces: Biometric Photosyn | 2130 | 455 | beta-000014 BETA - WEB - 403 Forbidden |
| 07/23 | 17:00 | 80 | 128.219.49.130 | LQ32.CT.ORNL.GOV | | Chemical and Material Science on Nanostructured Surfaces: Biometric Photosyn | 2285 | 455 | beta-000014 BETA - WEB - 403 Forbidden |
| 07/23 | 17:27 | 80 | 128.219.49.130 | LQ32.CT.ORNL.GOV | | Chemical and Material Science on Nanostructured Surfaces: Biometric Photosyn | 2575 | 455 | beta-000014 BETA - WEB - 403 Forbidden |
| | | | | | | Chemical and Material Science on | | | beta-000014 BETA |

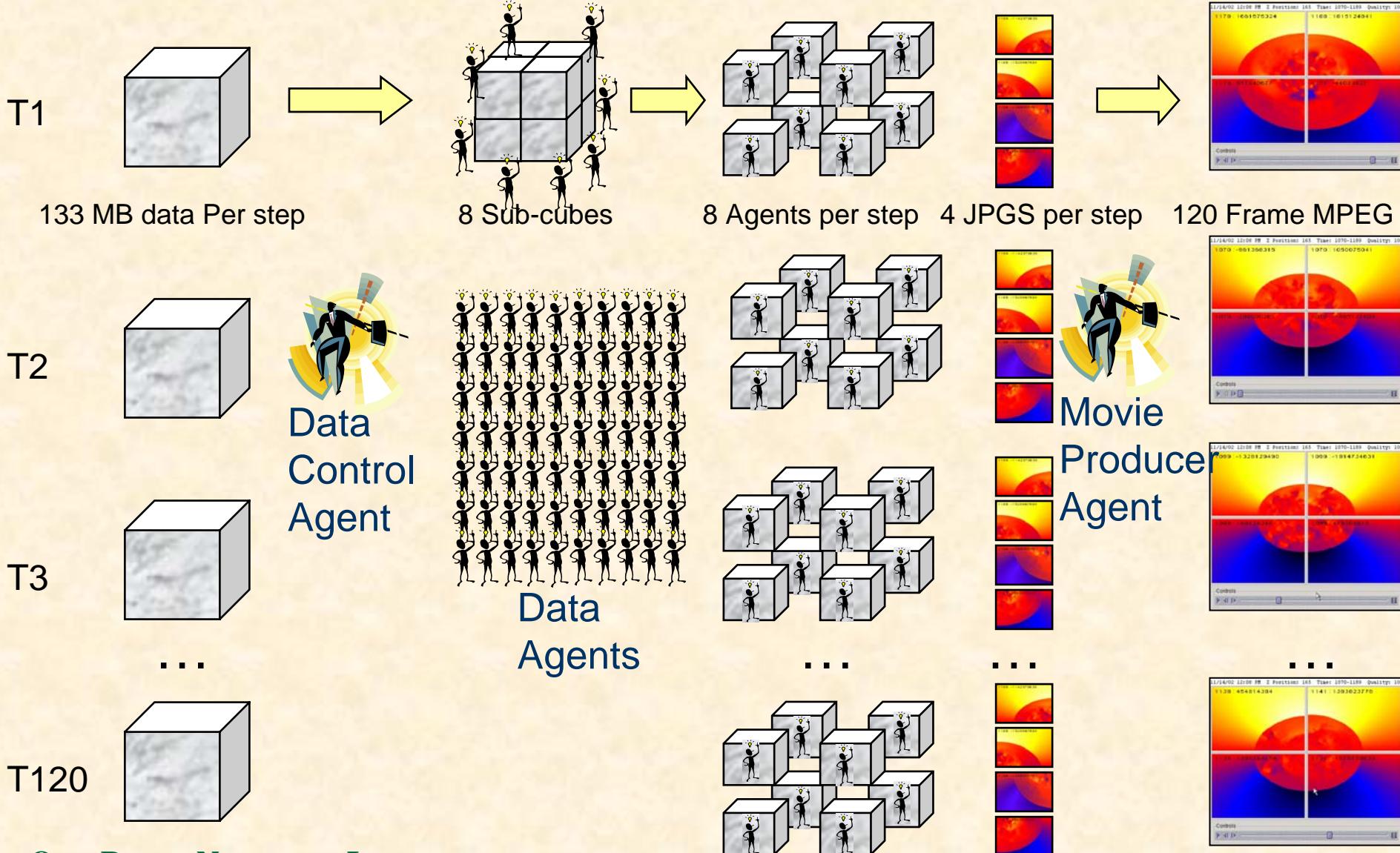
Hidden

Patent Pending

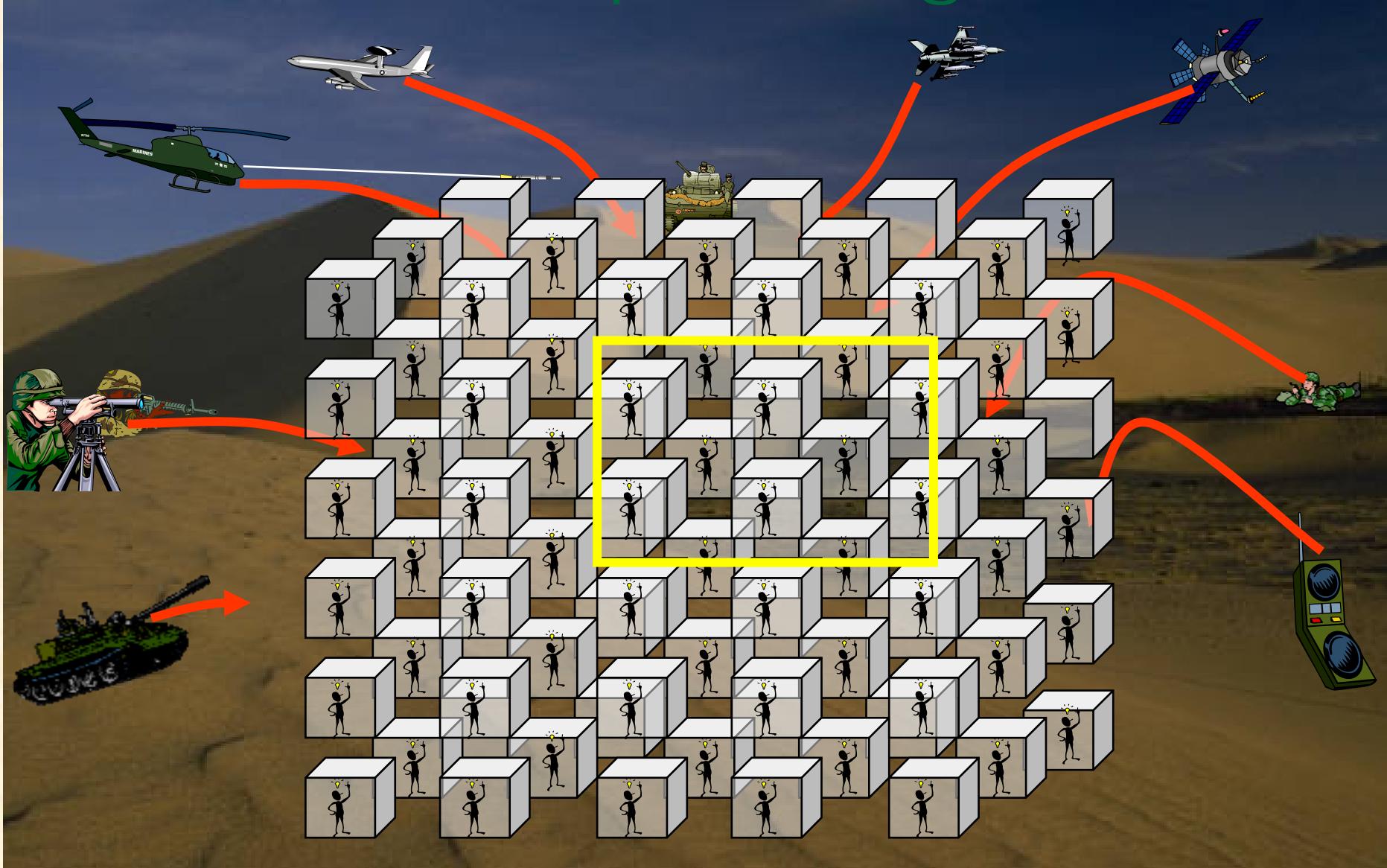
Agent Example “Pictures from Data”

- 1 Terabyte of streaming astrophysics data
- 1000 agents analyzing
 - 120 time steps of 300x300x300 matrix for 5 variables
 - 33 million units density in 194 files
- Each time step governed by an oversight agent which redraws picture with most recent information

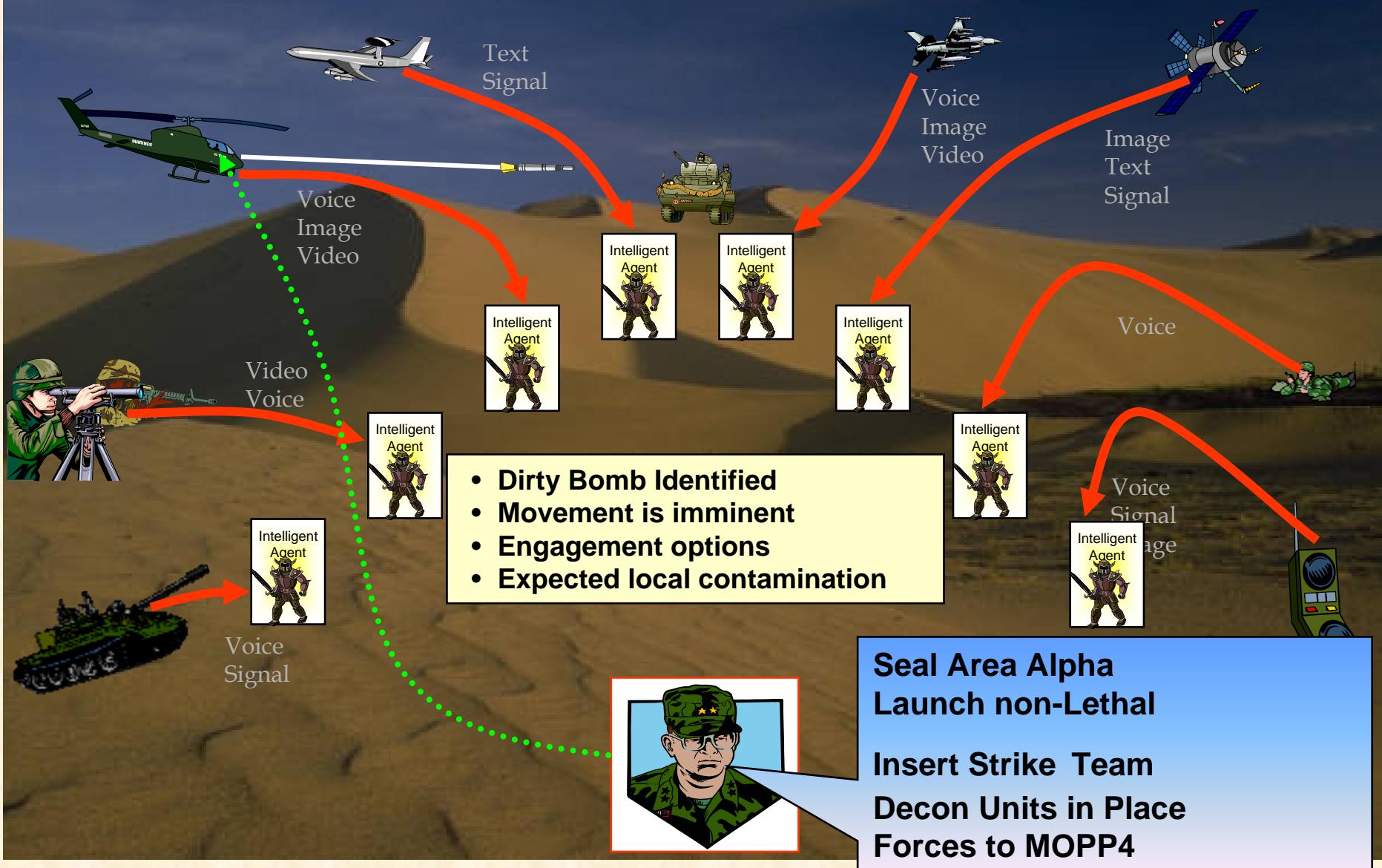
Astrophysics Common Operational Picture



Common Operating Picture



Future Battlespace – Forward Analysis



Knowledge Discovery

“The Art of the Possible”

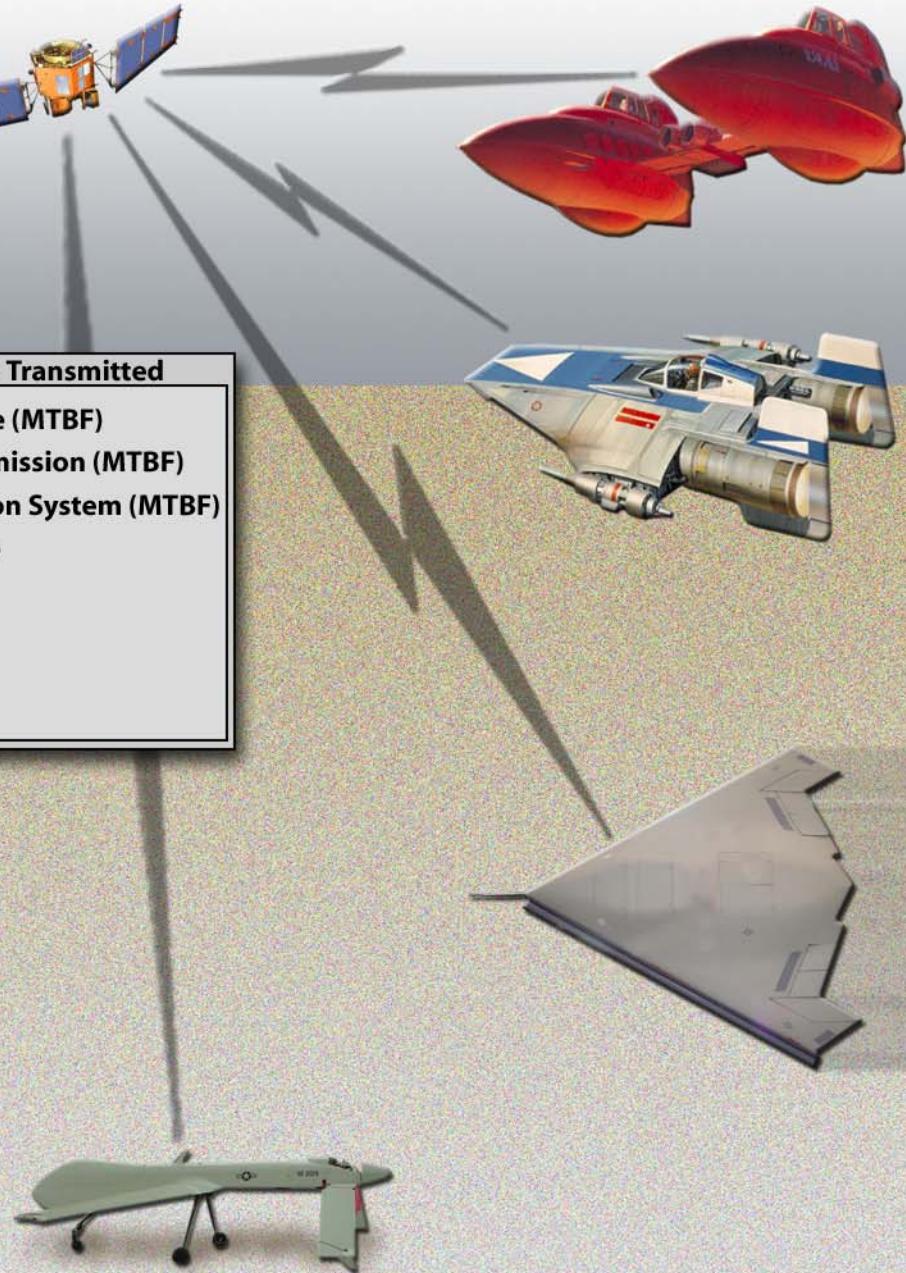


OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY

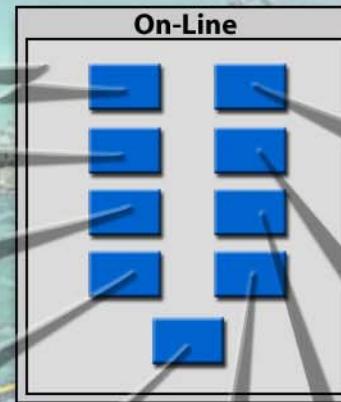
UT-BATTELLE



Sqdn Cdr



**Warning
Order
at 1200 Z**



JFC J3



| Units Available | Deployment List |
|-----------------|-----------------|
| | ACC |
| | MC |
| | AF |
| | SOC |
| | NAV |

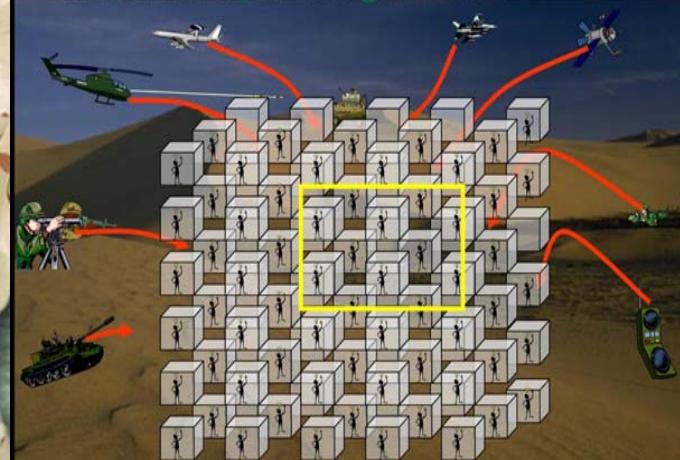
UID
Readiness
Load Plans
Movement Requests
Movement Plans
Support Slice
Sustainment

Given the theater capabilities
 the JFC requires—what forces
 can you contribute to the JF?

Net Order
 Situation
 Mission
 Concept
 Focus
 Log/Support
 C2
 Courses of Action

| On-Line | |
|----------|------|
| ACC | DLA |
| AFCC | NCC |
| USMCCC | DOD |
| SOCC | J5J3 |
| TRANSCOM | |
| | UID |

Common Operating Picture



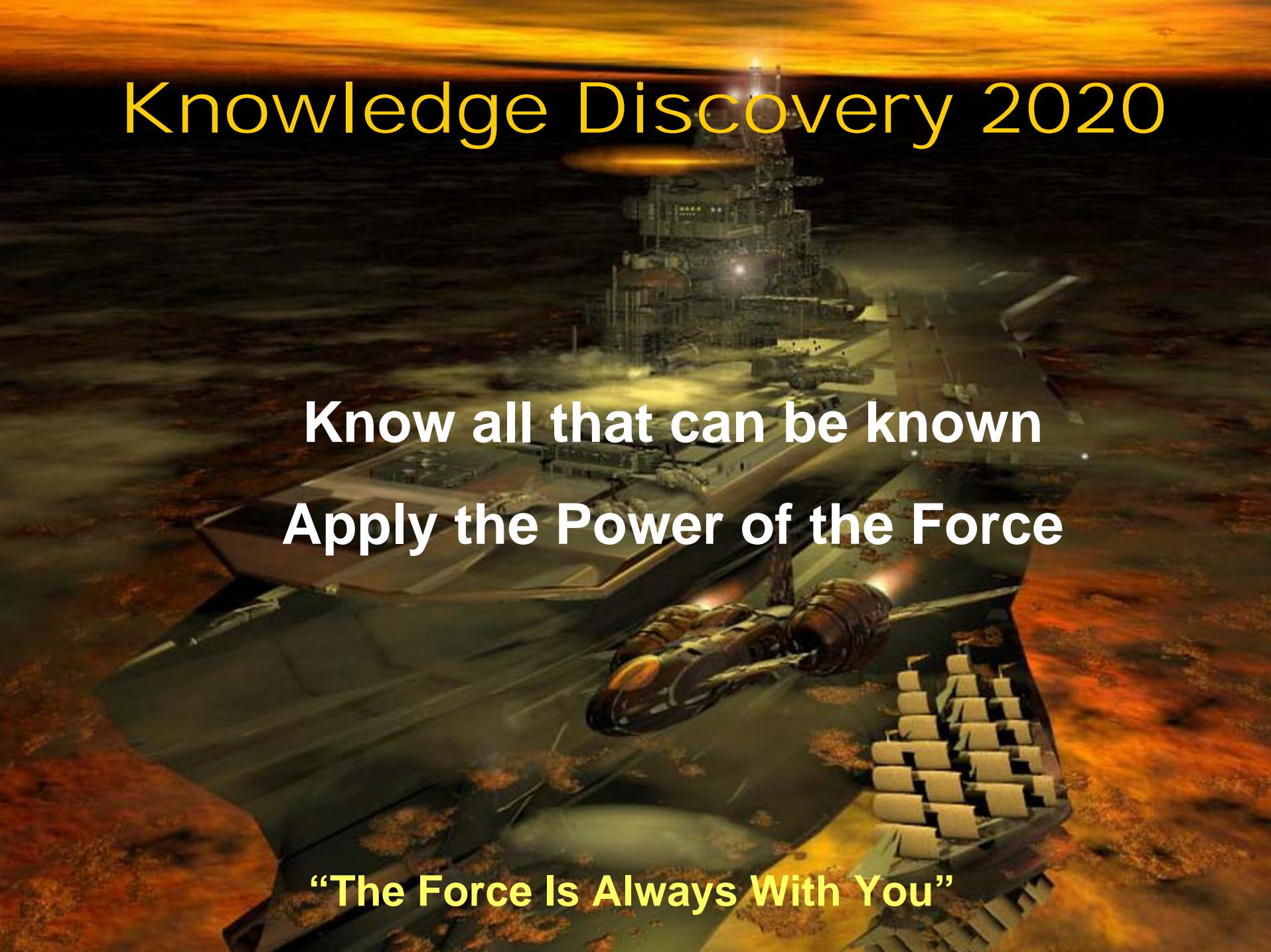
Day 5: Combat Power



Path to Success

- **Vision the Capability**
- **Articulate the Development Path and Priority**
- **Leverage the niche Centers of Excellence**

Knowledge Discovery 2020

A collage of Star Wars imagery set against a sunset or sunrise background. It includes a lightsaber hilt, a large cylindrical structure resembling the Death Star, and a TIE fighter flying through space.

Know all that can be known

Apply the Power of the Force

“The Force Is Always With You”

Solutions to Current Challenges: FY07-FY09

Major General Ted Bowlds

4 April 2007





AFRL Vision



Air Force S&T Vision

Anticipate, Find, Fix, Track, Target, Engage,
Assess, Anything, Anywhere, Anytime



AFMC Vision

War-winning
Capabilities...
On Time, On Cost

AFRL Vision

We **defend** America by
unleashing the power of
innovative science and
technology

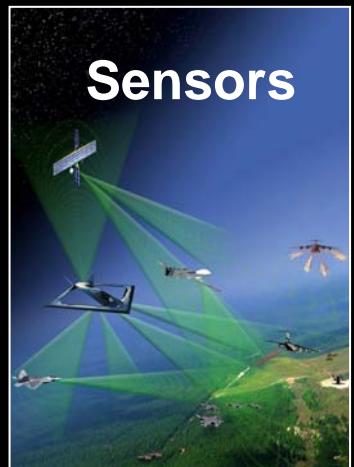
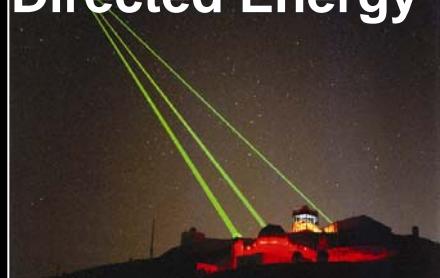




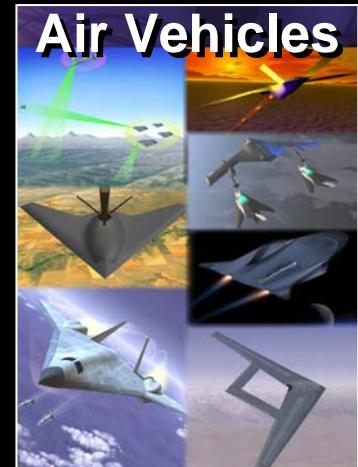
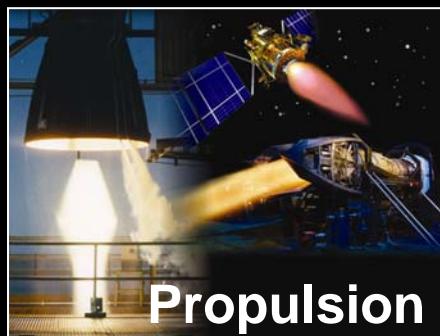
Core Work Areas



Directed Energy

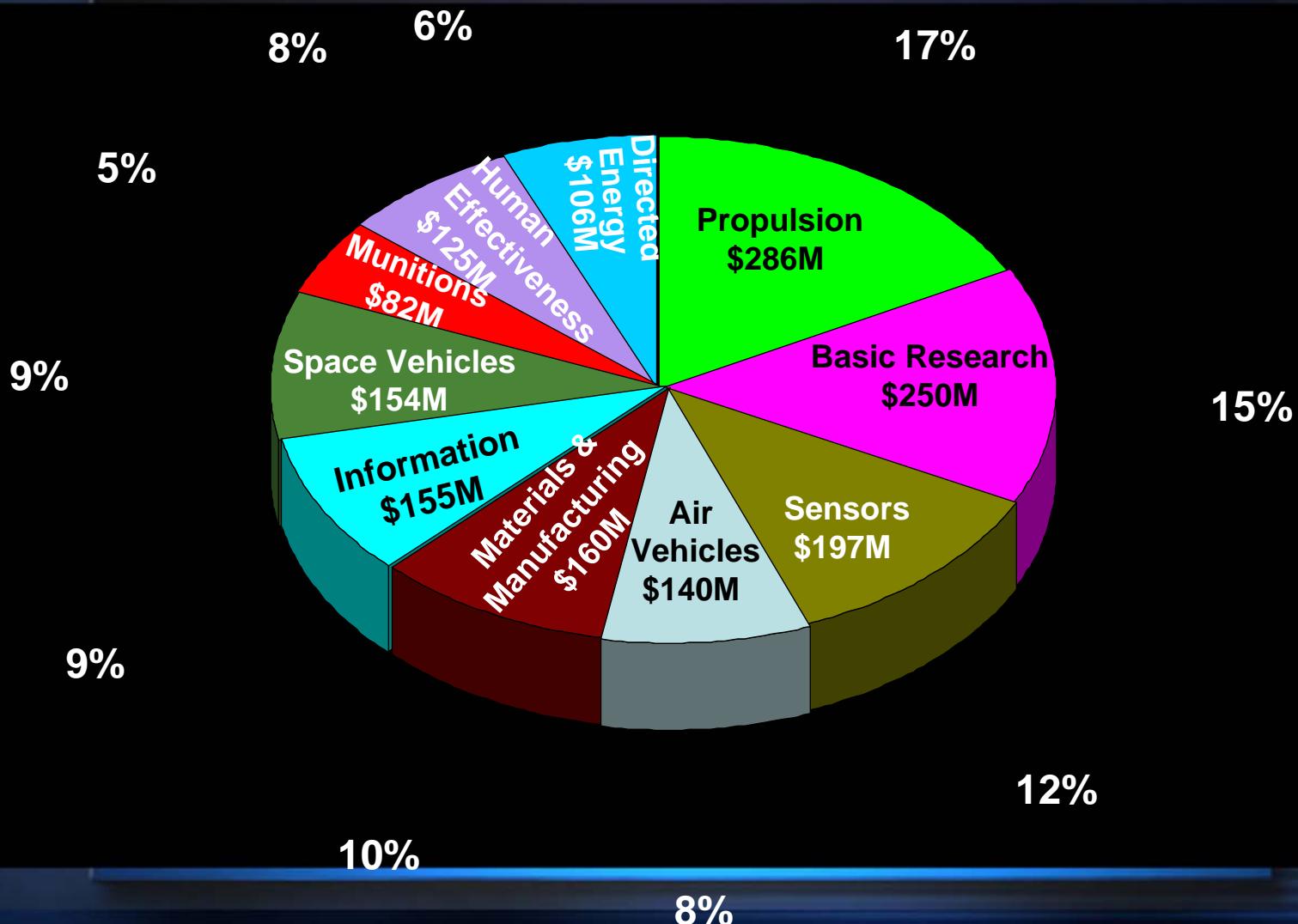


Human Effectiveness





AF Budget Investment By Tech Area



FY07 Presidential Budget
Values May Not Add Due to Rounding

AIR

SPACE

CYBERSPACE



AFRL Customers

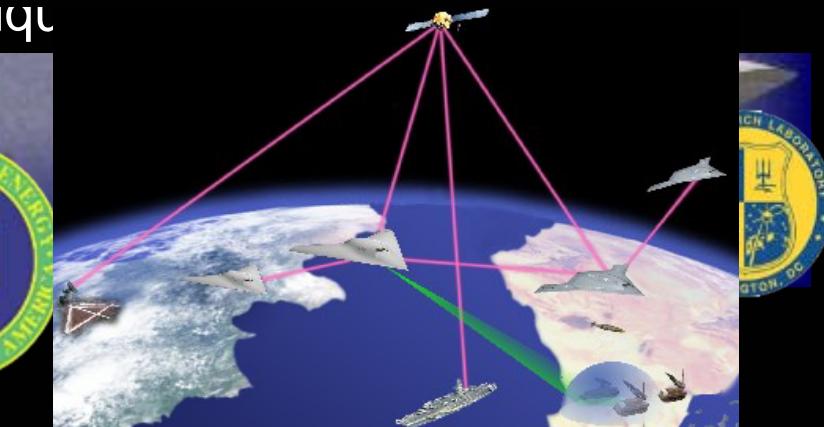


AF Senior Leadership

- Top-level guidance and strategy

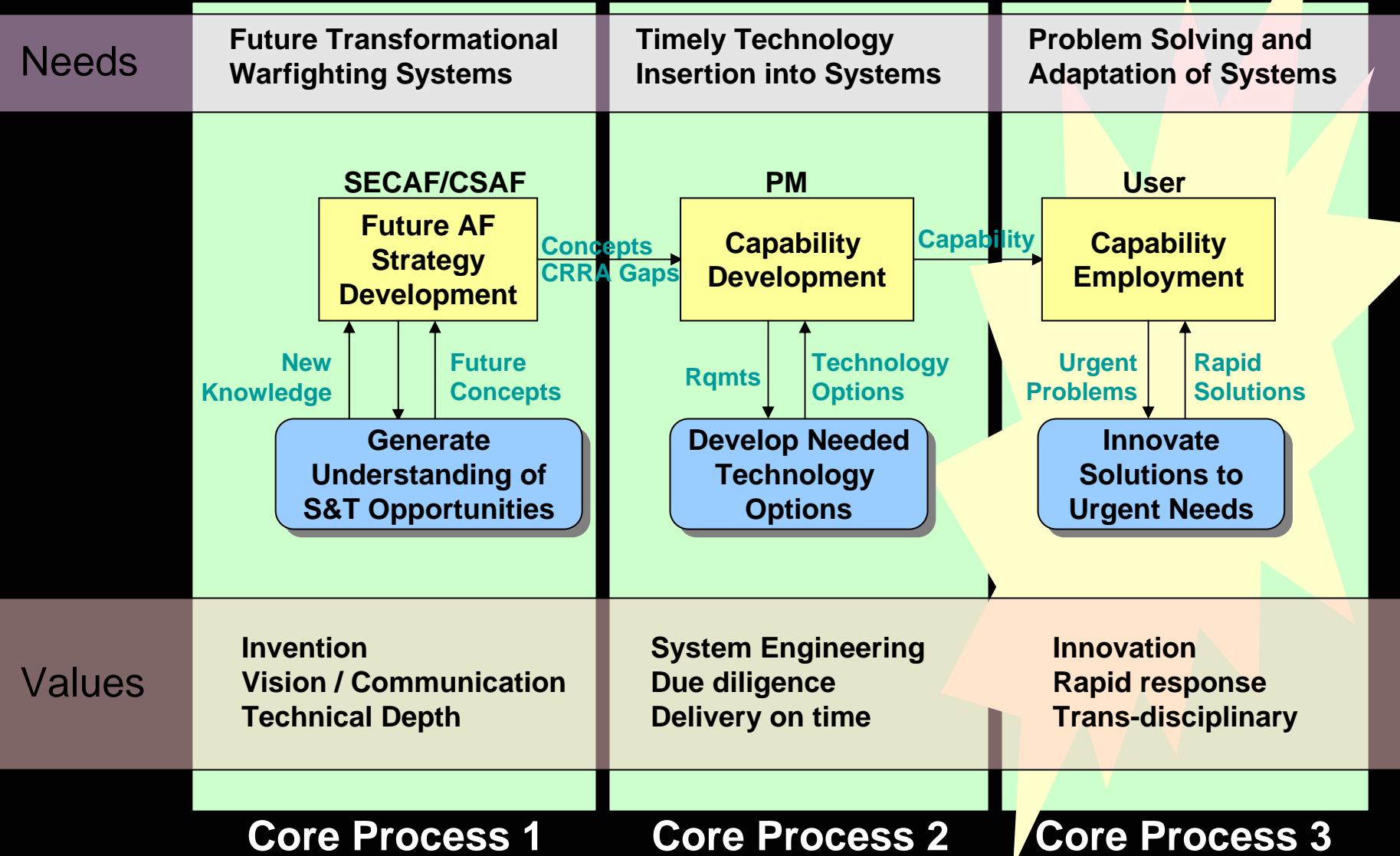
Program Managers (Capability Developers)

- Anticipate, Find, Fix, Track, Target, Engage, Shoot, anything, anywhere, anytime
- Core S&I concepts to meet operator needs
- Solve capability gaps and shape future concepts
- AFRL pushes to show operators what's possible





AFRL's Core Processes Aligned with Customer Needs

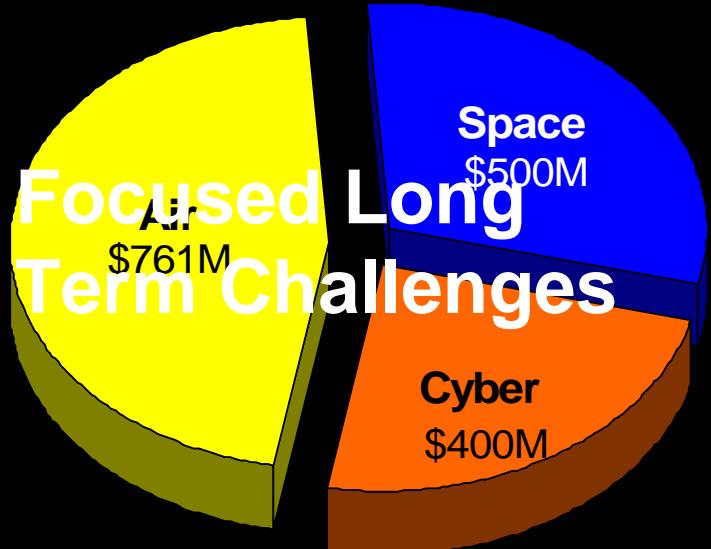
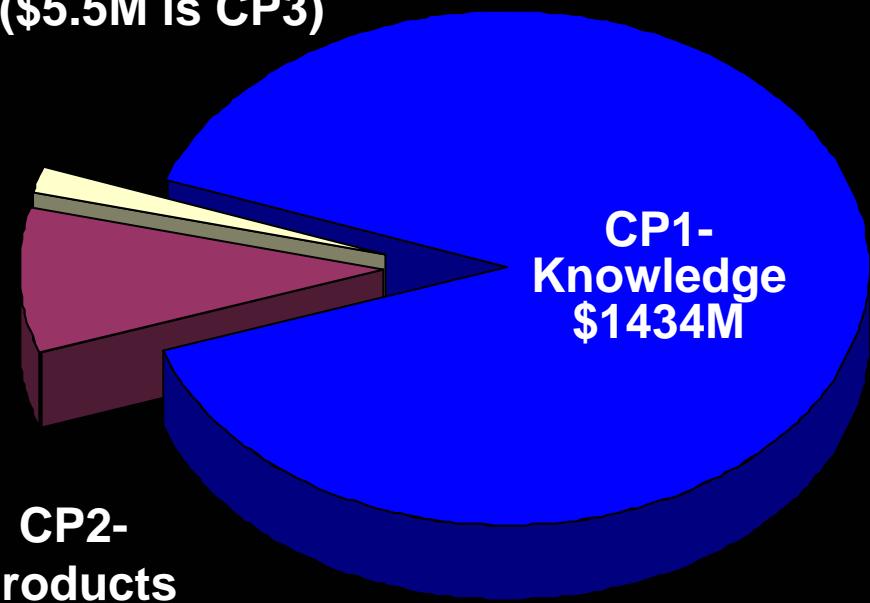




FY07 \$ in FY07 PB By Area



\$27M-Recent support*
(\$5.5M is CP3)



TOTAL: \$1.655 Billion

* Delivered to supporting current on-going combat operations

AIR

SPACE

CYBERSPACE



Core Process 1

Focused Long Term Challenges



Focused Long Term Challenges

- Define problems, address each problem

Anticipate, Define, Develop, Attack, Force Target, Engage,

Assess Anything, Anywhere, Anytime

AF²T²EA⁴



FLTC #1

FLTC #2

FLTC #3

FLTC #4

FLTC #5

FLTC #6

FLTC #7

FLTC #8

Problem #1

Problem #2

Problem #3

Problem #4



Program

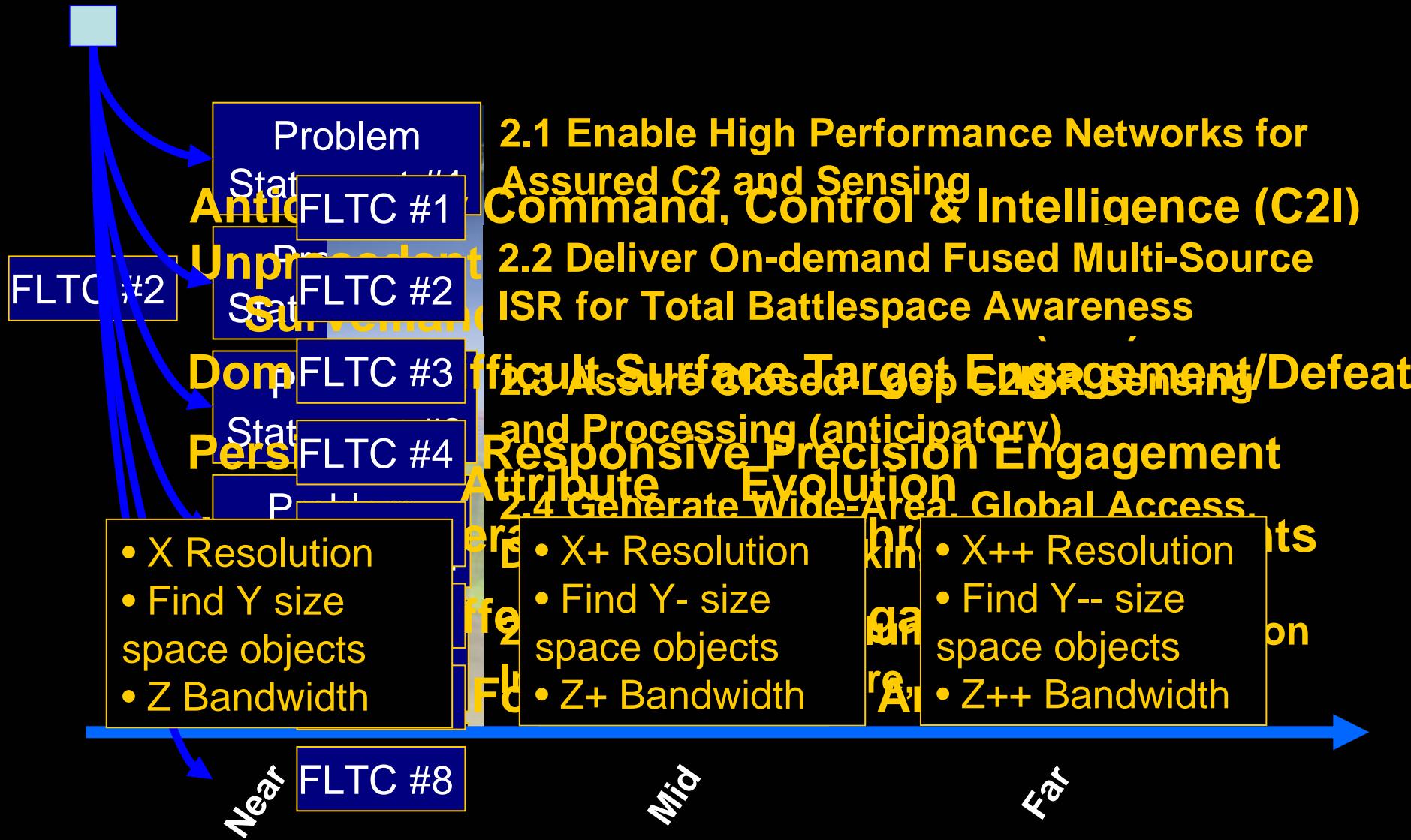
Program

Program

Many AFRL programs tied directly to the user's problems



FLTCs – Examined





FLTCs – Examined



FLTC #2

Unprecedented Proactive Intelligence, Surveillance, and Reconnaissance (ISR)

Problem Statement #2

2.2 Deliver On-demand Fused Multi-Source ISR for Total Battlespace Awareness

Mid-Term Attribute 2.2.1

Survivable, High-altitude, Long Endurance, Multi-INT Sensing for Battlespace Awareness

Product 2.2.1.1

Improved Light Aircraft Structures (VA)

Product 2.2.1.2

Structurally Integrated Aircraft Antennas (VA)

Internally Funded Program

TRL MRL

Partially or Un-Funded Program

TRL MRL

Jointly Funded Program

TRL MRL

Externally Funded Program

TRL MRL

TRL Technology Readiness Level

MRL Manufacture Readiness Level



Socialization Process to Date



- 20 Jun 06 ACC/A8 and ACC Staff
- 21 Jun 06 AFSPC/A3 and AFSPC Staff
- 26 Jun 06 AFSOC/A8/A5 and AFSOC Staff
- 27 Jun 06 AFFTC Staff
- 28 Jun 06 AETC/A5/A8 and AETC Staff
- 14 Jul 06 SMC/CC
- 20 Jul 06 AFC2ISRC/A8 and AFC2ISRC Staff
- 25 Jul 06 ESC
- 28 Jul 06 AMC/A5 and AMC Staff
- 3 Aug 06 DTRA
- 7 Aug 06 Air Staff – A3, A8, AQR
- 30 Aug 06 NSSO S&T IPT
- 30 Aug 06 Air War College
- 31 Aug 06 AFSPC/CC
- 1 Sep 06 AF SAB
- 5 Sep 06 PACOM
- 7 Sep 06 ONR
- 11 Sep 06 N-81 Study Team
- 21 Sep 06 AFSPC



Socialization Process to Date



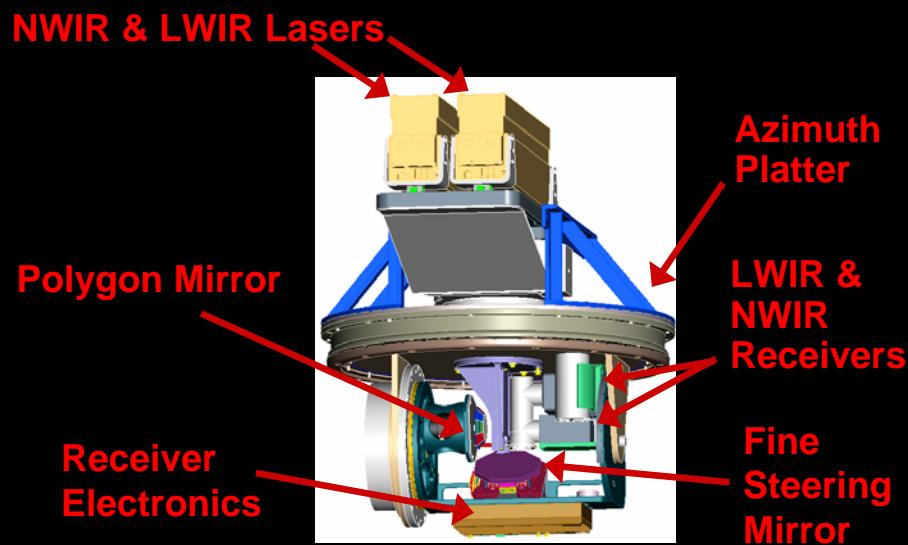
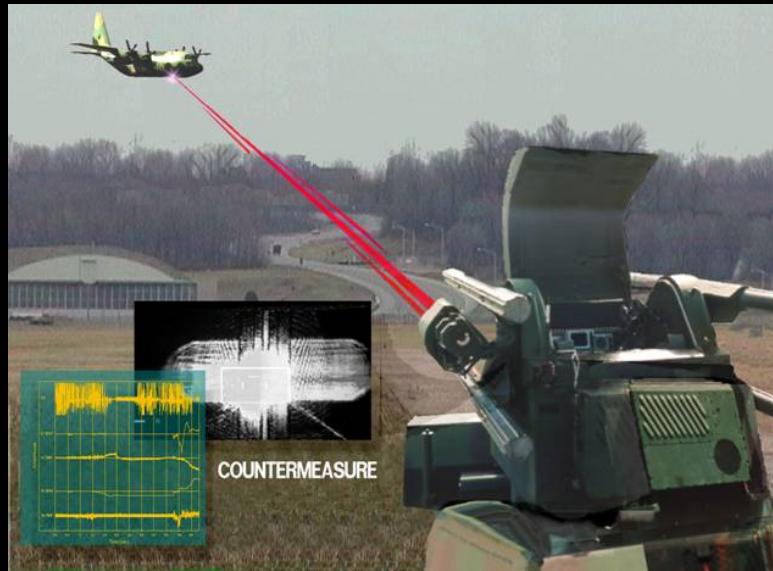
- 25 Sep 06 NAVAIR Process Council
- 28 Sep 06 AFSOC
- 5 Oct 06 Dir NASA Dryden
- 5 Oct 06 AFRL-AFIT Summit
- 6 Oct 06 AFSPC/CV Brief
- 19 Oct 06 DTRA
- 14 Nov 06 USSOCOM
- 30 Nov 06 ACC/AFC2ISRC
- 8 Dec 06 NASA HQs
- 19 Dec 06 ASC/XR
- 3 Jan 07 SAF/AQ
- 3 Jan 07 DDR&E
- 9 – 11 Jan 07 Deep Dive Workshop #1 – DC
- 17 Jan 07 Cyber Command
- 31 Jan 07 Dr Erbsloe, AMC/ST
- 5 Feb 07 ASC Aeronautical Enterprise IPT
- 7 – 8 Mar 07 Oak Ridge National Lab
- 8 Mar 07 Idaho National Lab
- 14 Mar 07 NGA



Technology Insertion Day/Night EO/IR Tracker CM



- Locates and defeats / denies use of passive infrared fire control systems and active laser trackers on man-portable and mobile SAM systems
 - Compatible with AFSOC/SOCOM platforms using DIRCM IR CM systems
- Detects threat IR sensors before weapon launch
- Provides threat location and possible threat classification
- Provides option to avoid, deny or counter the threat beyond missile launch range
- Denies enemy the ability to operate passively (forces RF use) and increases survivability
- Negates AAA and laser beam rider tracking



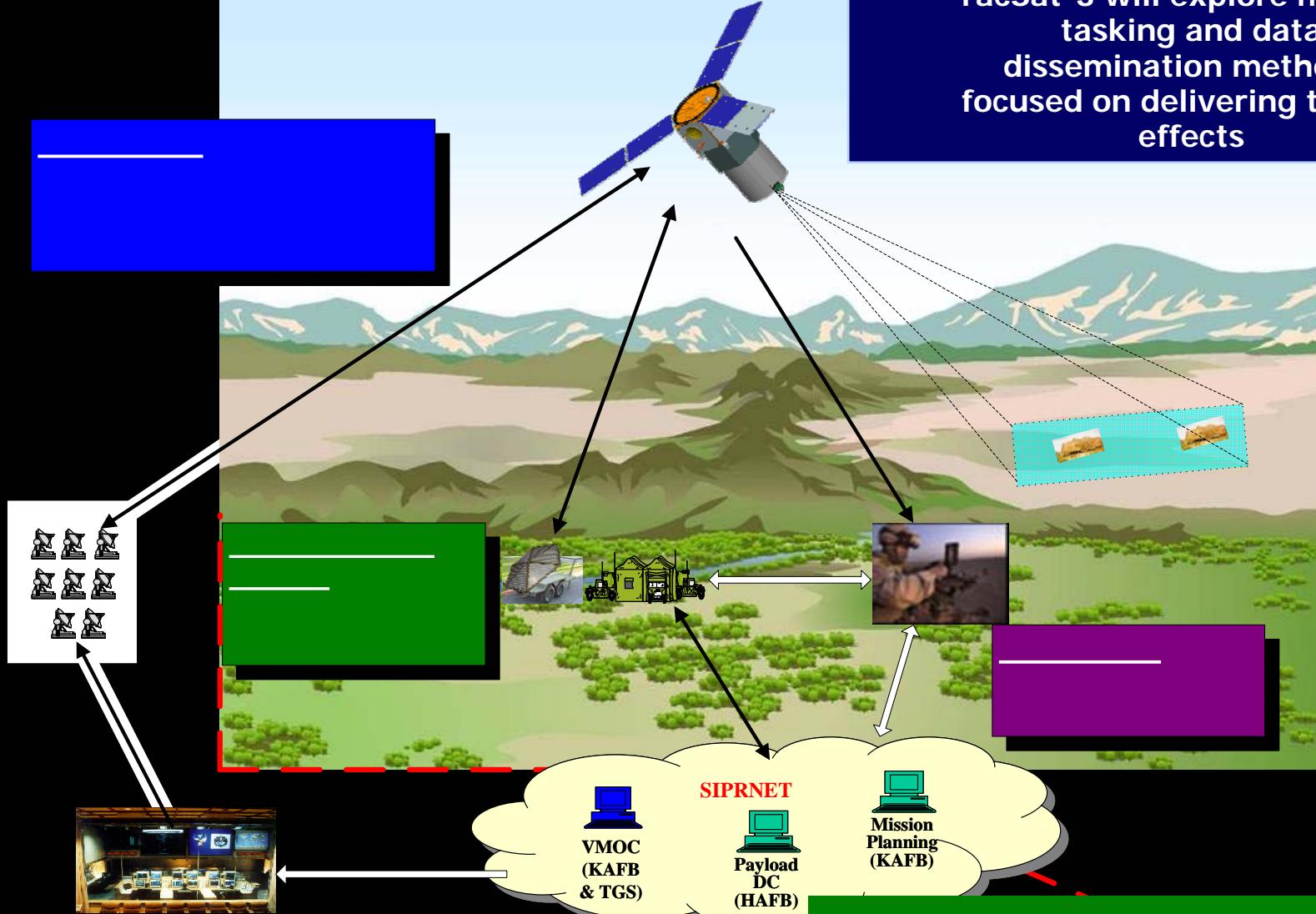


Technology Insertion

TacSat-3 Real Time Downlink & C2



TacSat-3 will explore multiple tasking and data dissemination methods; focused on delivering tactical effects



In Partnership with Army SMDC



BAO BRITES ATD SPIRAL 2



(PM – Lt. Josh Johnson, AFRL/PR)

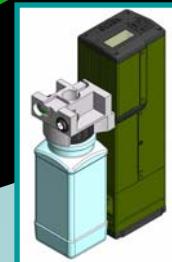
Solid Oxide Fuel Cell

~600 W·hr/kg



Methanol Fuel Cells

~500 W·hr/kg



Zinc Air

~350 W·hr/kg



High Energy

Rechargeable Li Metal

~300 W·hr/kg



Optimized Li Ion
~200 W·hr/kg



High Power

Lithium Ion
~200 W·hr/kg



Power Management



Spiral 1 33% Wgt Savings

25%

Spiral 3
50%

Spiral 2





Technology Insertion

Trusted Tactical Weaponeering for Cyberspace

(PM – Rick Metzger, AFRL/IF)



► Program objectives

- Combines disparate cyber programs throughout the AF and Intelligence community
- Enhance C2 with remote cyberspace attack capabilities
 - Third leg of “C2 Triad”



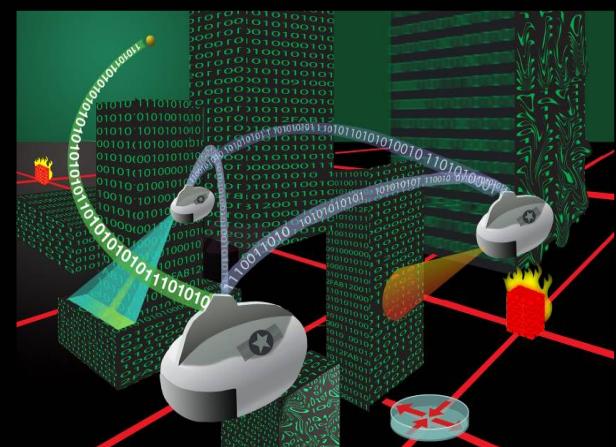
► Benefits to the Warfighter

- Enables warfighter to dominate the cyberspace: strike anytime, anywhere
- Global reach: unprecedented access beyond physical and geo-political boundaries.
- Gathers intelligence for IPB
- Acts as non-traditional ISR asset: supports BDA



► Schedule

- Contract (Jan 06)
- Demo (Sep 09)

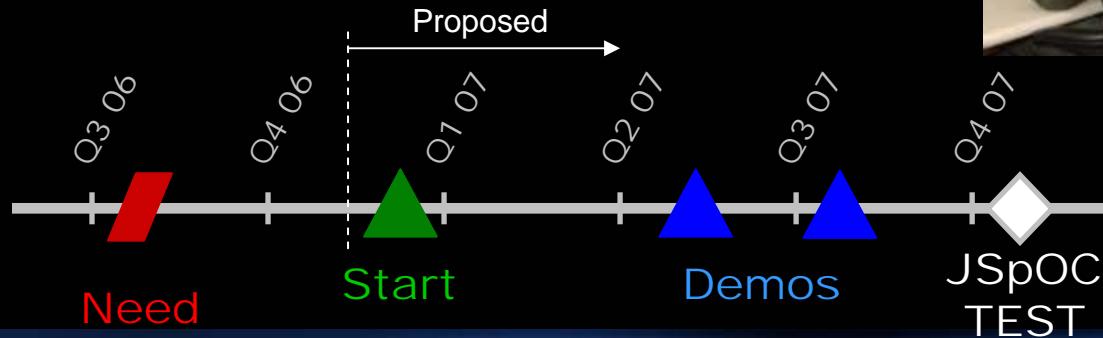
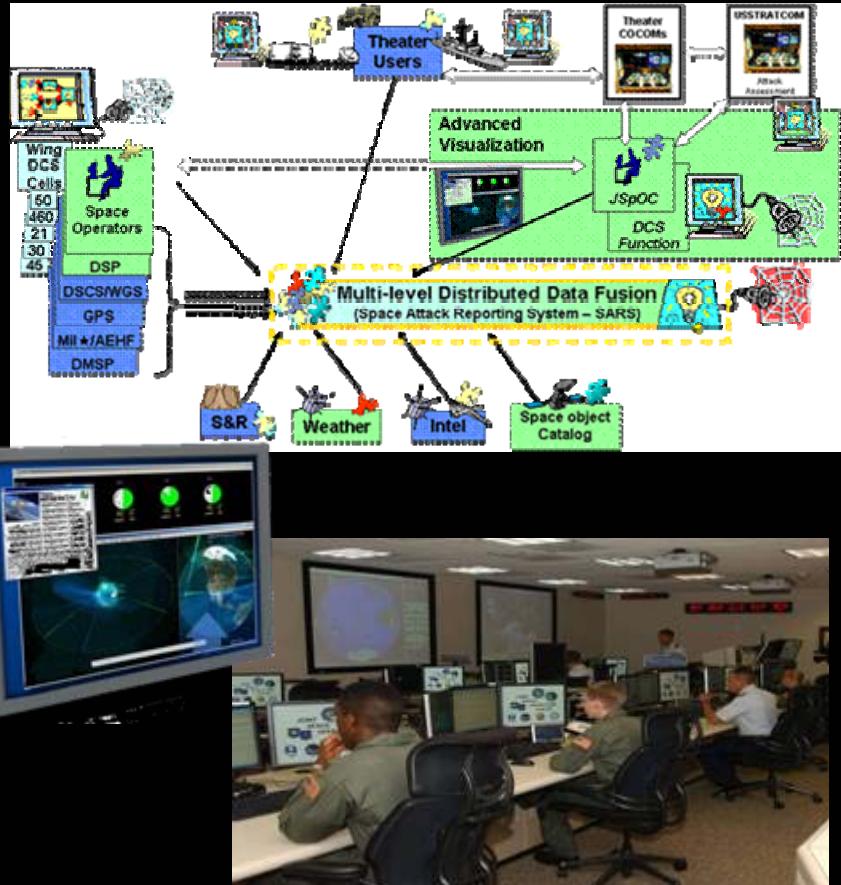




AFRL Rapid Reaction Project Space Situation Awareness



- Commander Joint Space Operations Urgent Need
 - Rapid ability to assess space situation using existing information
- 70% Quick-to-Field Solution Identified
 - Data fusion and intuitive display of telemetry, ephemeris, and space weather data
 - Plan to validate in Joint Space Operations Center (JSpOC)
- Coordinating plan with broader community (AFSPC, SMC, etc)



Rapid Response

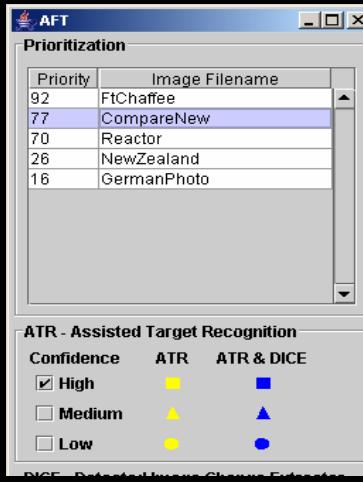
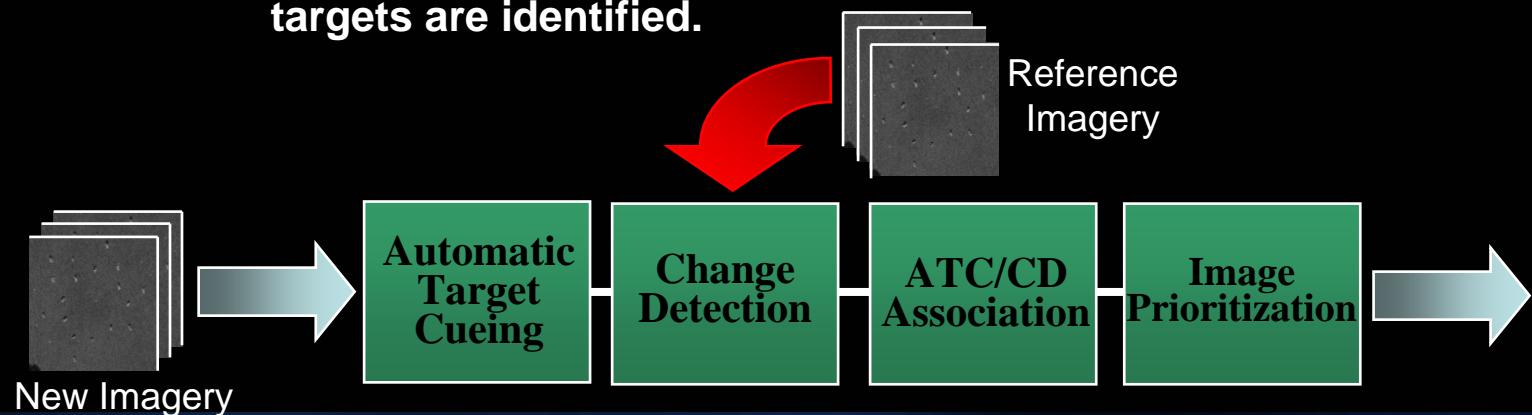
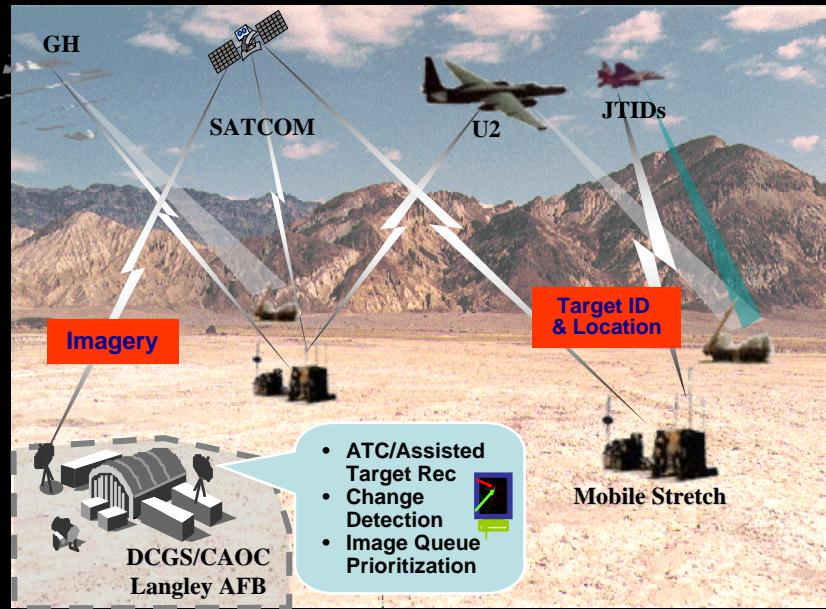


Assisted Target Recognition for Time Critical Targeting



(PM – Lt. Amanda Martin, AFRL/SN)

- Dynamic high value targets are only vulnerable for short periods of time
- Image Analysts are responsible for ever increasing, large volumes of data
- Solution
 - Automatic Target Cueing (ATC)
 - Automatic Target Detection
 - Assisted Target Recognition
 - Change Detection (CD)
 - Compares images collected at different times to identify change.
 - Image Prioritization.
 - Sources of information are correlated and images are most likely to contain targets are identified.



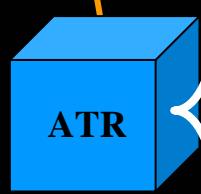


Potential ATR Uses – Shorten Timelines



Current Process

| | |
|----------|-----------|
| Scene 31 | Report 31 |
| Scene 30 | |
| Scene 29 | |
| Scene 28 | |
| Scene 27 | |
| Scene 26 | |
| Scene 25 | |
| Scene 24 | |
| Scene 23 | |
| Scene 22 | |
| Scene 21 | |
| Scene 20 | |
| Scene 19 | |
| Scene 18 | |
| Scene 17 | |
| Scene 16 | |
| Scene 15 | |
| Scene 14 | |
| Scene 13 | |
| Scene 12 | |
| Scene 11 | |
| Scene 10 | |
| Scene 9 | |
| Scene 8 | |
| Scene 7 | |
| Scene 6 | |
| Scene 5 | |
| Scene 4 | |
| Scene 3 | |
| Scene 2 | |
| Scene 1 | |



Exploitation Queue Prioritization

| | |
|----------|-----------|
| Scene 30 | |
| Scene 29 | |
| Scene 28 | |
| Scene 27 | |
| Scene 26 | |
| Scene 25 | |
| Scene 24 | |
| Scene 23 | |
| Scene 22 | |
| Scene 21 | |
| Scene 20 | |
| Scene 19 | |
| Scene 18 | |
| Scene 31 | Report 16 |
| Scene 17 | Report 15 |
| Scene 16 | Report 14 |
| Scene 15 | Report 13 |
| Scene 14 | Report 12 |
| Scene 13 | Report 11 |
| Scene 12 | Report 10 |
| Scene 11 | Report 9 |
| Scene 10 | Report 8 |
| Scene 9 | Report 7 |
| Scene 8 | Report 6 |
| Scene 7 | Report 5 |
| Scene 6 | Report 4 |
| Scene 5 | Report 3 |
| Scene 4 | Report 2 |
| Scene 3 | Report 1 |
| Scene 2 | |
| Scene 1 | |



Key Observations



- Collaboration a must
- Direct warfighter-scientist interaction essential
- Put high risk efforts in lab, not in programs



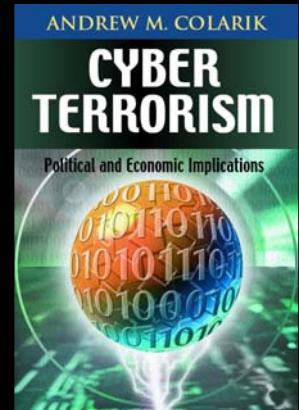
THE AIR FORCE RESEARCH LABORATORY
LEAD | DISCOVER | DEVELOP | DELIVER



AFRL Rapid Reaction Project Cyberspace



- Addressing urgent needs for MAJCOMs (PACOM) and soon to be:
 - Cyber Command
 - ISR Command
- Understanding the urgency for rapid action within the cyber arena
 - Access, stealth and persistence
 - Cyber tracking technology
 - BDA/IPB
 - PSYOPS
 - Cybercraft
 - Anticipatory modeling of human behavior
- Identified CP3 projects
 - Information Support Server Environment Guard
 - Web Enabled Timeline Analysis
 - DODIIS Trusted Workstation
 - Joint Targeting Toolkit





Core Process Alignment with Customer Timelines and Needs



SECAF, Chief – long view, strategic planning



PM, Industry/Product Center – next generation, acquisition timelines



Warfighter – day-to-day, employing capabilities

| | | | | | | | | | | | | | | | | |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|

rapidly deliver technical innovation, driven by warfighter emergencies – reshape today's battles

Core Process 3
CP3



develop technology options that meet the needs of capability developers – shape today's Air Force

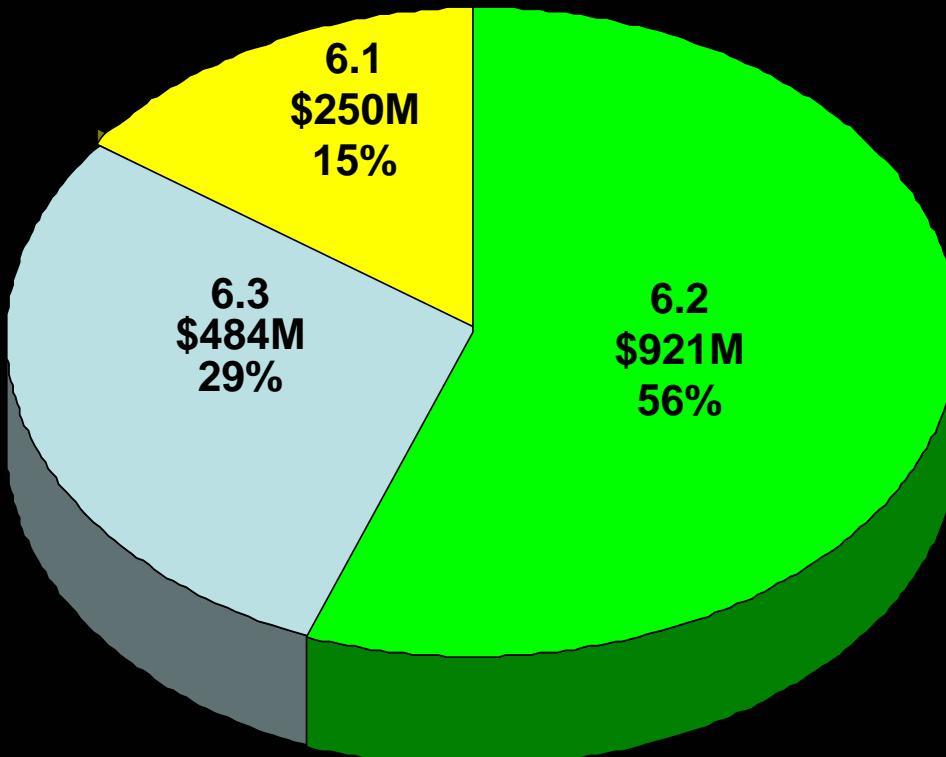
Core Process 2
CP2

conduct long-term research, driven by a bold technology goal – shape the future Air Force

Core Process 1
CP1



AF Budget Investment By Budget Activity



TOTAL: \$1.655 Billion



AFRL Technology Transitions to F/A-22



**Low
Observables
Technology**

**Advanced
Avionics**

**Mission
Integrated
Transparencies**

**Ultra
Reliable
Radar**

**Advanced
Metallic
Structures**

**Thermoplastic
Composite
Structures**

**Advanced Engines
for Non-A/B
Supercruise**

**Weapons
Launcher**

**Integrated
Flight
Control**

**2D Thrust
Vectored Nozzles**

\$900M S&T Investment in 1970s - 1990s

CE



AFRL Technology Transitions to F-35





AFRL Technology Transitions to UAVs



Electric Actuators

**Automatic Collision
Avoidance**

**Operator-Vehicle
Interface**

**Multifunctional
Structures**

Low Cost Structures

**Reliable Autonomous
Control**

**Revolutionary
Manufacturing
Processes**

**Antenna
Integration Testing**

**Unusual
Configuration
Aerodynamics**

**Continuous Moldline
Technology**

**Command, Control,
& Communications**

**Advanced
Propulsion
Integration**

Aerial

Refueling/Rearming

**Small/Micro UAV
Development**

**Miniaturized
Munitions**

**Advanced
Targeting**

AIR

SPACE

CYBERSPACE



AFRL Technology Transitions to Space



Propulsion/Propellants

Electric Power - Solar,
Chemical & Mechanical

Communications

Radiation Hardening

Antennas

Microelectromechanical
Systems

Ground Processing

Synthetic Aperture
Radar

Electro-Optic
Sensors

Signal Processors

Satellites

Structures & Materials

AIR

SPACE

CYBERSPACE



AFRL Information Technology Transitions



AIR

SPACE

CYBERSPACE



AFRL Technology Transitions to Munitions



GPS/INS Guidance Solutions

IMU Miniaturization

& Cost Reduction

Anti-Jam
Technologies

Enhanced Blast
Explosives



High Fidelity
Design Tools

High Strength
Warhead Cases

Optimized W/H
Geometry
for Penetration

SPACE

System Demonstrations
Insensitive Munitions

AIR

CYBERSPACE



AFRL Technologies Support Operation Iraqi Freedom



- Battlefield Air Operations Kit
- Anti-Jam GPS
- Massive Ordnance Air Burst
- Panoramic Night Vision Goggles
- CRASH Prompt Agent Defeat
- Surface Target Ordnance Package
- Laser Eye Protection



AIR

SPACE

CYBERSPACE



AFRL Human Effectiveness Technology Transitions



AIR

SPACE

CYBERSPACE



AF Office of Scientific Research



- Physics & Electronics
- Mathematics & Space Sciences
- Aerospace & Materials Sciences
- Chemistry & Life Sciences

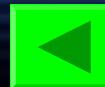




Air Vehicles Directorate

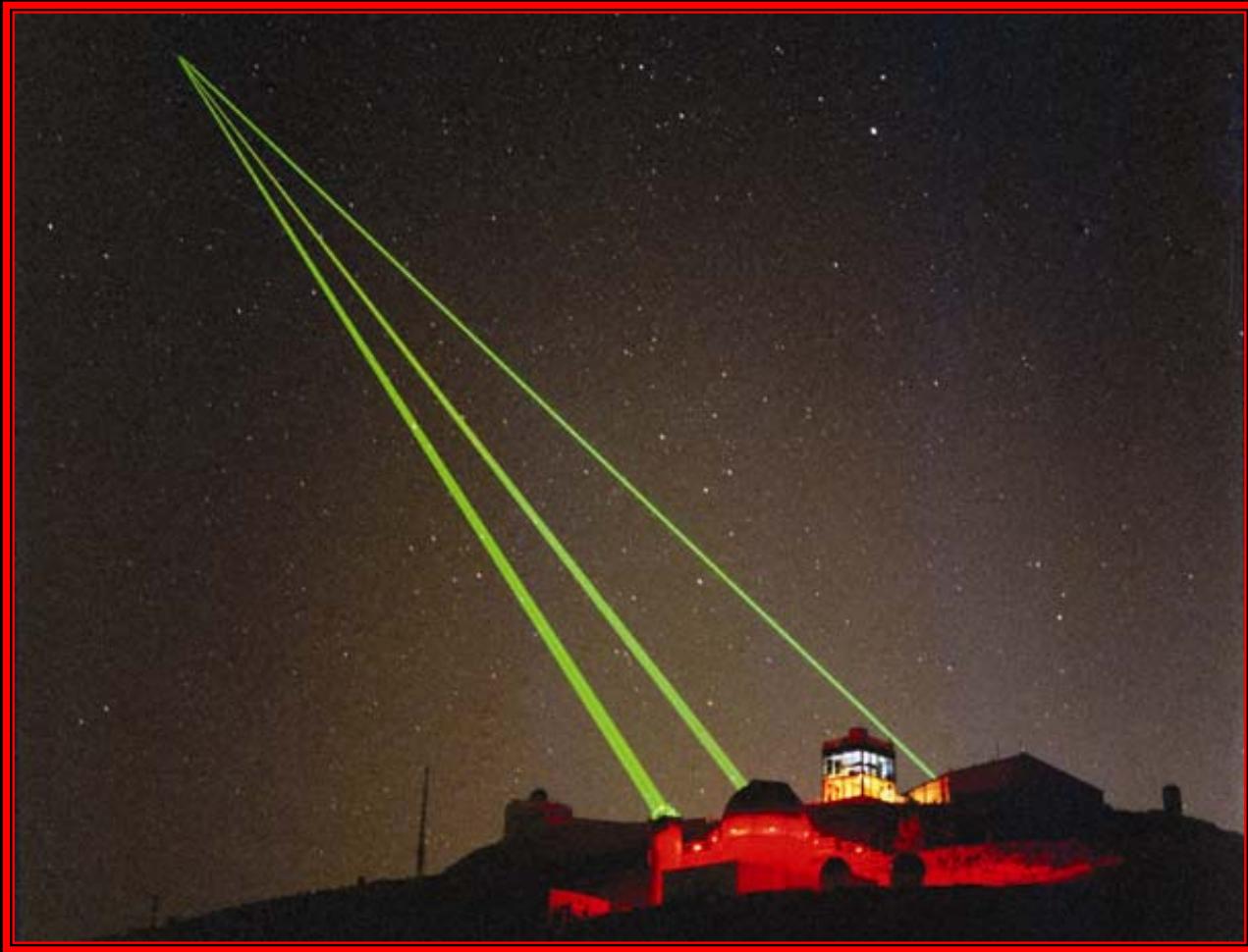


- Sustaining Today's Fleet
- Unmanned Air Vehicles
- Space Access & Future Strike Technologies





Directed Energy Directorate



- Lasers
- High Power Microwaves
- Advanced Optics & Imaging





Human Effectiveness Directorate



- Warfighter Training
- Crew System Interface
- Bioeffects & Protection
- Deployment & Sustainment





Information Directorate



- Dynamic Planning & Execution
- Global Awareness
- Global Information Enterprise





Materials & Manufacturing Directorate



- Metals, Ceramics
- Polymers, Composites, & Coatings
- Laser-Hardened & Sensor Materials
- Manufacturing Technology
- Non-Destructive Evaluation
- System Support





Munitions Directorate (MN)

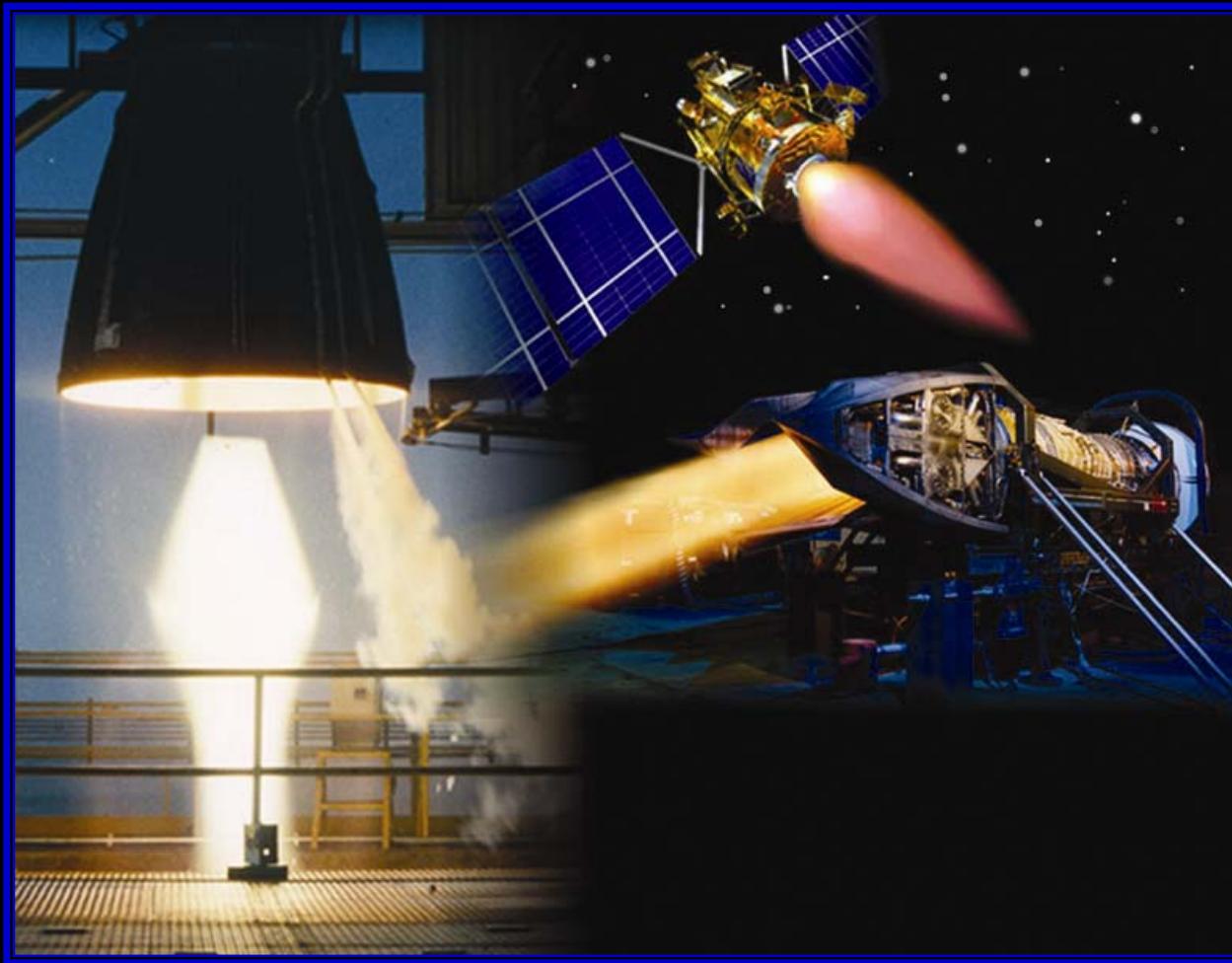


- Precision Munitions
- Alternative Effects Weaponry
- Counterproliferation





Propulsion Directorate (PR)



- Turbine Engines
- Fuels & Lubricants
- Liquid & Solid Rocket Power





Sensors Directorate (SN)



- Radio Frequency Sensors & Countermeasures
- Electro-Optical Sensors & Countermeasures
- Automatic Target Recognition & Sensor Fusion





Space Vehicles Directorate



- Space-Based Surveillance
- Space Capability Protection
- Counterspace
- Space Access



The ATLAS Powered Rope Ascender

Enabling Rapid Vertical Mobility

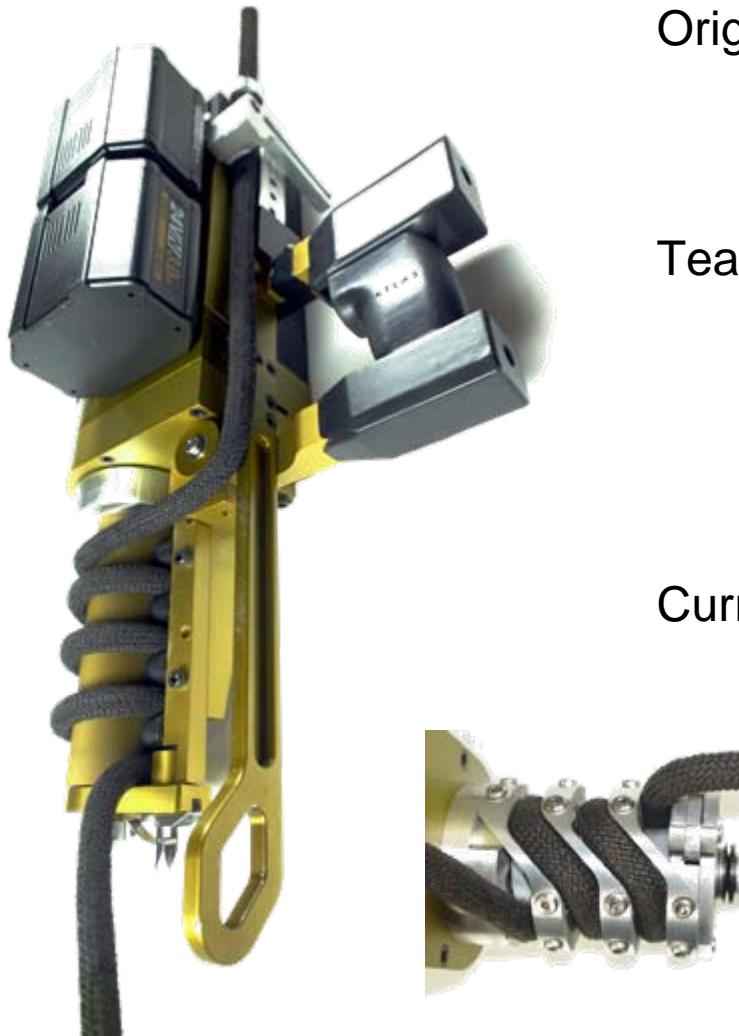


Student Technology Transition



- Fall 2004: Team ATLAS Enters *MIT-ISN Soldier Design Competition*
- Spring 2005: Working Prototype wins 3rd Place
- Atlas Devices, LLC Incorporates, files patent
- Summer 2005: Demo at Infantry Center at Ft. Benning
- Since then: 3 more patents, Partnerships, further iterations, and contract with US Army Rapid Equipping Force

The Device



Original Challenge: 50 ft in 5 seconds with 250 lbs
-Device Weight: <25 lbs!
-5 kW Mechanical Output in 25 lb package

Team ATLAS Original Design:

- Similar to Cordless Power Tool
- High Output DC Powertrain
- Innovative Capstan Mechanism
- Achieved 50 ft in 7 seconds with 250 lbs

Current Model: SRA03-1

- 17 lbs total weight
- 350 lbs at 5 ft/sec
- 600 ft vertical per charge

$$T_1 = T_2 e^{(\mu\theta)}$$



Multiple Iterations, Multiple Uses

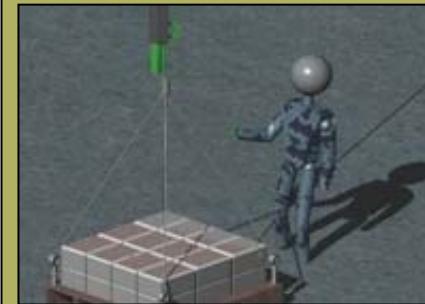
Powered Ascent



Rescue, Towing



Equipment Hauling



...and More

- ...
 - Ship Boarding
 - Maritime Rescue
 - Obstacle creation & removal
 - Gate/door breaching
 - Cave exploration
 - Maintenance access
 - Industrial load positioning
 - Helicopter rescue
 - Portable winching
 - Minefield Raking
 - IED Removal
- ...

Current Focus

- US Army Rapid Equipping Force Delivery
- Development of further iterations for Specialized Applications
- Upgrading capabilities: Lighter-Weight, Smaller, Faster
- Graduation
- *Further sales:* Small-batch orders of the SRA03-1 for testing, evaluation & refinement



ATLAS DEVICES is:



Tim Fofonoff

- Ph.D. Candidate, S.M. Mech. Eng. MIT
- Member of MIT ISN and BioInstrumentation Lab
- Winner of 2006 \$50K MIT Hatsopoulos prize



Bryan Schmid

- S.M., S.B. Mech. Eng. MIT
- Serial Entrepreneur
- Padmakar P. Lele undergraduate teaching award



Nathan Ball

- S.M. Student, S.B. Mech. Eng. MIT
- All American pole-vaulter
- Winner of 2007 \$30K Lemelson-MIT Student Prize



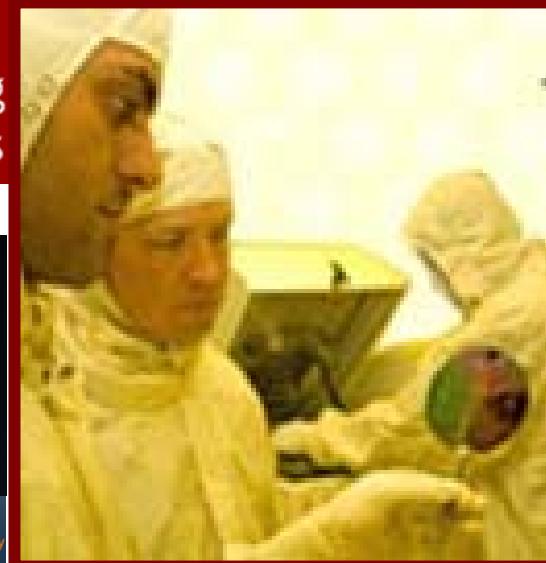
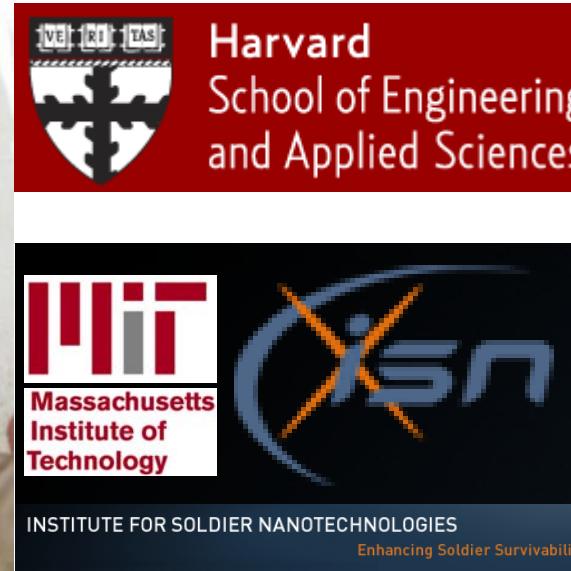
Daniel Walker

- S.M. Student, S.B. Mech. Eng. MIT
- Experienced climber and rescue instructor
- Former MIT outing club president



Emerging Technologies from the Army-Funded Institute for Soldier Nanotechnologies (ISN)

by MAJ Rex Blair
*Harvard Applied Physics Graduate Student and
Uniformed Army Scientist at ISN*

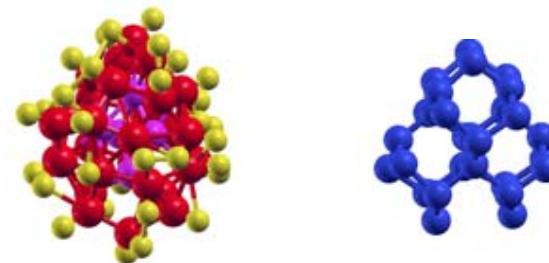
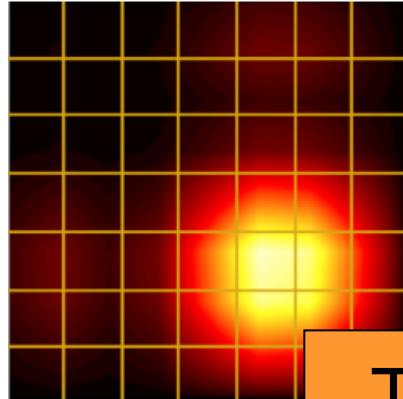


***Boots to Benchtop...
and Back...***

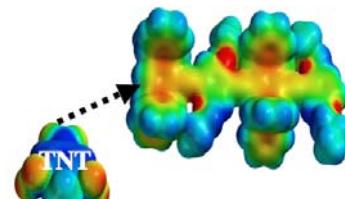
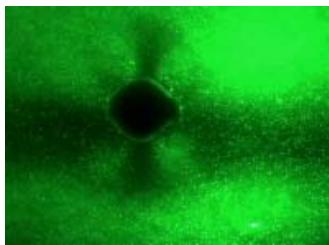


Institute for Soldier Nanotechnologies

MISSION



To dramatically improve the survivability of the Soldier by working at & extending the frontiers of **Nanotechnology** through fundamental research





ISN Research to Enable Key Soldier Capabilities



ISN Dedicated Facility

State of the art instrumentation

Multidisciplinary

40 Faculty (8 Departments)

80 Grad students

30 Post-docs

2 Uniformed Army Scientists

4 Civilian Army Scientists

8 Industry Visiting Scientists



Industry Consortium



Army S&T Labs

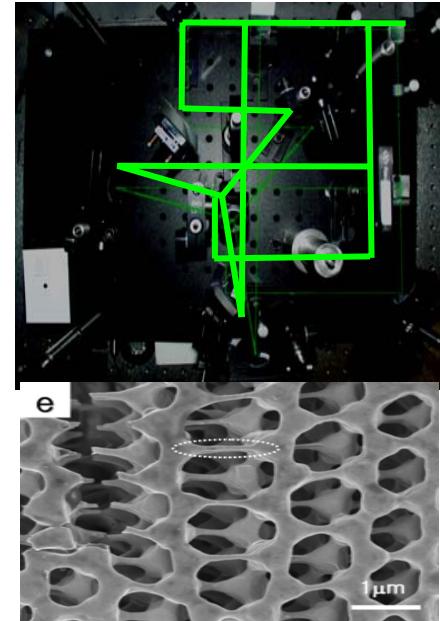
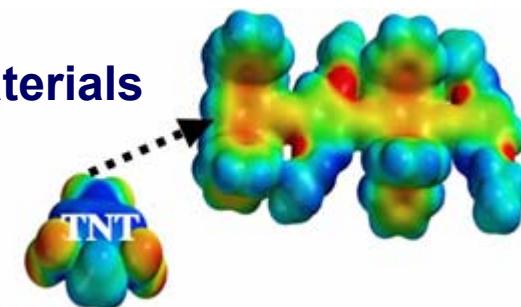




ISN Research to Enable Key Soldier Capabilities



- **Protect:**
 - Lightweight, strong structural materials
 - **Ballistic + blast protection**
- **Detect unseen threats:**
 - Explosives, chemicals, biotoxins...
- **Enhance:**
 - Adaptive, multifunctional materials
 - Soldier performance monitoring (medical status)
 - Injury triage and treatment for survivability
- **Improve Performance:**
 - Mechanical actuators: “exo-muscle”
 - Situational awareness
 - Give individual Soldiers small-unit capabilities: chem-bio, awareness, far forward medical care



Microtrusses via 3D photolithography

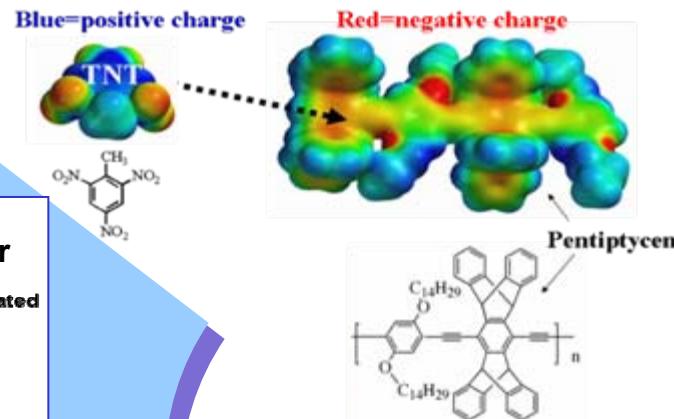
*Soldiers are FIRST customers
for improved protection*



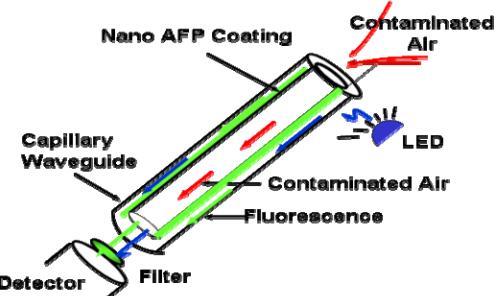
Science Making a Difference for Soldiers: FIDO Explosives Detector



**MOLECULAR
ENGINEERING:**
designed molecules



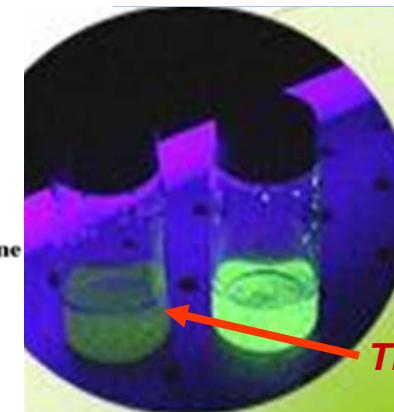
OPTICAL ENGINEERING:
integrated Detector/Sampler



REPACKAGING:
from DARPA Dog Nose concept
to real Warfighter Device



DETECTION OPPORTUNITY:
Hidden explosives give off traces of
chemicals, which may be detected.



SCIENCE: Amplifying
Fluorescing Polymer
(AFP) developed by
MIT ISN Prof Swager
glows green, but
quenches when
TNT is present.

TNT Detected

Assessments:
USMC in Iraq (2004), ATEC in Iraq (2005)

Procurements:
**SOCOM (2005),
PMs (2006) for handheld + robot-integrated**



Army's
Greatest
Invention
Award
2005



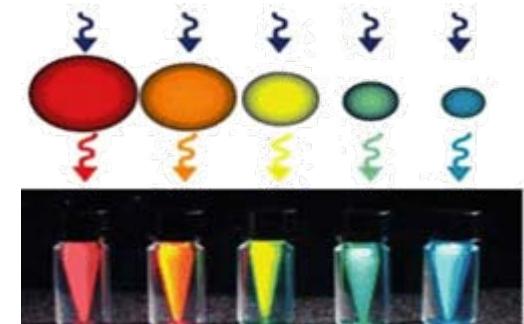


Projects with Medical and Other Military Benefit Can Speed Technology Adoption (more than “Availability”)



- Near IR Quantum dots are functionalized for cancer, injected into patient; migrate to cancer cells (Bawendi)
 - Surgeon assesses Near IR image before a single cut
 - Cluster == much cancer, few dots == less surgery
- MEMS Microchip addresses Hemorrhagic shock (Cima)
 - Enables rapid drug delivery
 - Military is “lead user,” leverages FDA approval process

Rapid drug delivery via MEMS device:
prevent hemorrhagic shock



Near IR Quantum Dots
functionalized for Cancer



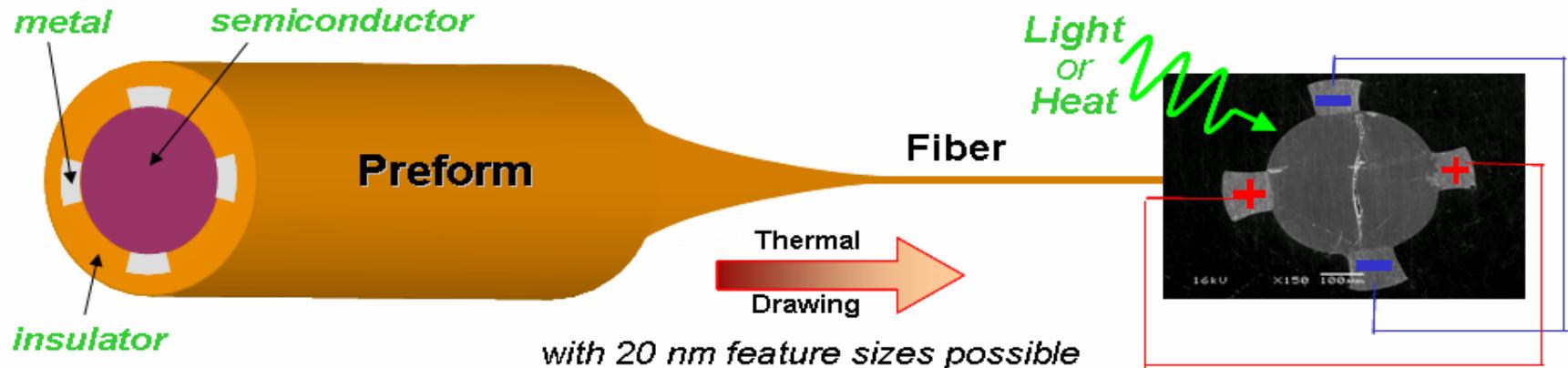
Explore implant (long term) and “Epi-Pen” (short term) types of delivery

*Leveraging med research & partners:
Saves lives + grows market + accelerates tech
adoption
== reduces costs + risks for Soldier applications*

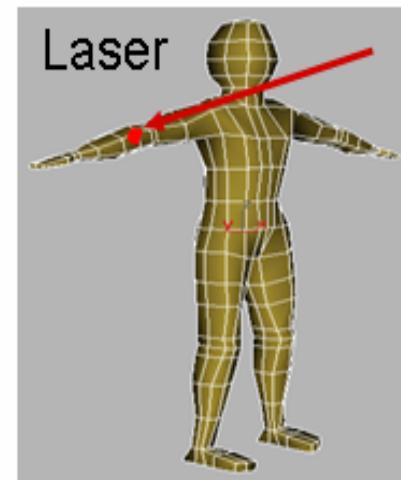


Fiber Web Linear Sensors

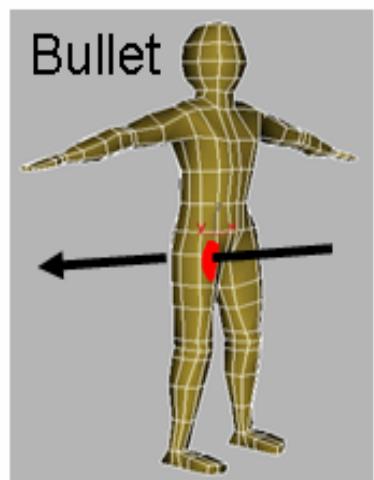
★ Optoelectronic fiber-devices for light, heat, & acoustic sensing:
Full-body sensing (Photonic Band-gap Fibers)– new paradigm fibers & fabrics that can see, feel, hear...



Full Body ID;
Laser-to-Uniform
Non-RF
Communications;
Improved MILES

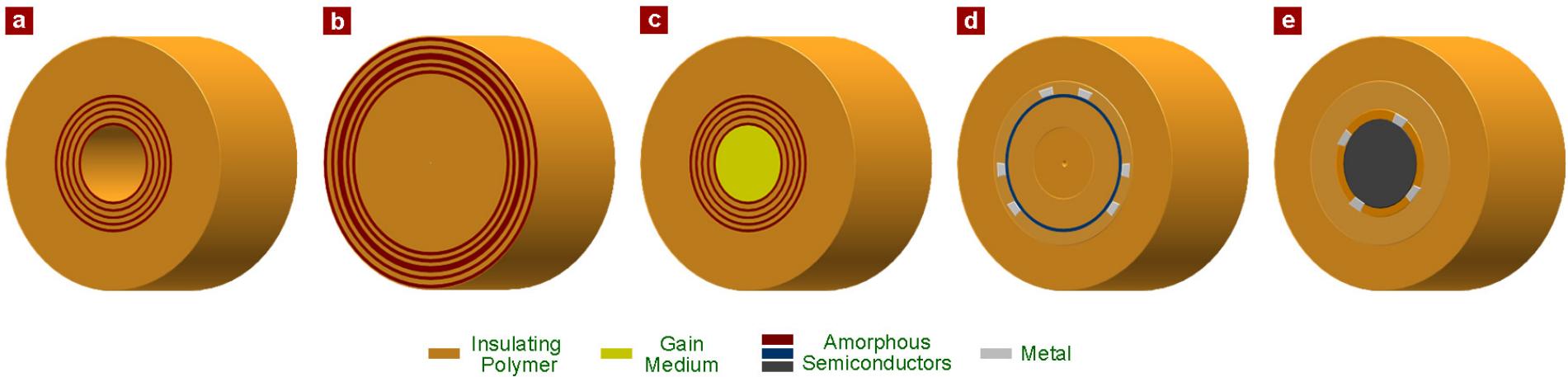


Full Body
Thermal Sensing
Remote Triage





Fiber Web Linear Sensors: Tunable Metal-Insulator-Semiconductor Fiber Devices



Hollow
transmission
fibers

Optical cavity
fibers

Surface
emitting fiber
lasers

Thermal
detector
fibers

Optical
detector
fibers



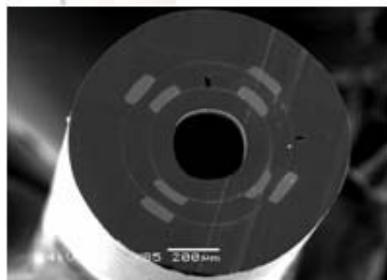
ICOM-H Identification & Communication Helmet Prototype



Design, fabricate, and implement an optoelectronic **fiber-device** covering for combat ID and line-of-sight IR communication



Prof. Y. Fink
Prof. J. Joannopoulos
MAJ R. Blair



Optoelectronic Fiber-Device

Preform Fab

Fiber Drawing

Specs

PEQ-2

Soldier Helmet

Fiber Device

ID & IR Comm's

Characterization



NSC –
PM SOF Warrior
R. Elder



ID & Comms Multifunctional Helmet



ICOM-H Identification & Communication Helmet Prototype





Be Alert for Opportunities: MIT ISN Soldier Design Competition

MIT

SOLDIER DESIGN COMPETITION

Final Judging &
\$10,000 in Awards

Tuesday, February 17, 2004
Wong Auditorium, E51-115

5:30 pm Poster Session
6:30 pm Final Presentations and Judging
9:30 pm Winners Announced

Teams will present prototypes of:
• Parachute assist ball canisters
• Air chronically generated that helps paratrooper body heat
• Air cushion launched aerial photographic cameras
• Hand held wire spotters for drivers, crews, "take of safety" equipment communication
• and more!



Judging the SDC



CSM Michael Kelso & COL Forrest examine TacShot's rocket-based photography system



Directional Hand-Arm Communication System
Tom Eng, Byron Hsu, Forrest Liou, David Lin, Han Xu

SOLDIER PROBLEM / CHALLENGE

Problem

- Soldiers cannot always talk to one another, hear one another, or see one another.

Challenge

- Develop system that enables soldiers in a squad or fire team to communicate both directional and non-directional messages without visual contact with team members.
- System must allow quick, one-handed operation.

PROJECTED FINAL CAPABILITIES

- Robust under all combat and peacekeeping environments.
- Secure, short range wireless inter-soldier data transmission.
- Addition of new commands on-the-fly.

COL Terry Clemons, QM DCD & COL Ernest Forrest, TSM-Soldier, look on as Team TXI demo their novel parachute canopy release mechanism



Team Surreptiles, with COL Ted Johnson (center), show off their check for placing 2nd in the SDC finals



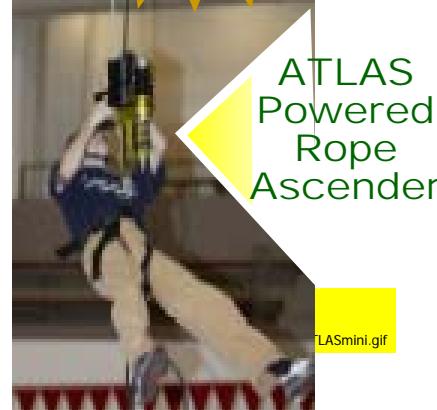
ISN Soldier Design Competition: Dealing with Success....



Directional Gesture Communication System

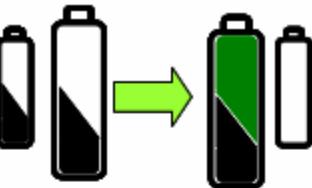
SDC-1: Digitized Hand-Arm Signals with Personal Direction Reference: Incorporated as RallyPoint, Inc., won 2 Army SBIRs (\$750K) for Future Force Warrior (FFW) Handwear Computer Input Device

Army & Marine Challenges Ensure relevance



ATLAS
Powered
Rope
Ascender

USMA Team Supercharged



MIT Team Xitome:
Kailas Narendran, CEO

SDC2: Battery Power Scavengers:

PEO Soldier – 2 designs (MIT + USMA) for Soldier field testing by Fall 2005 (\$250K); FY07 contract for Iraq



Goal: Involve undergrads in ISN
→ Solve real problems, to help Warfighters
→ Involve military: USMA, mentors, judges
→ Innovate to make a difference sooner:
technology for Warfighters



TacShot



Broader Impact & Media Coverage

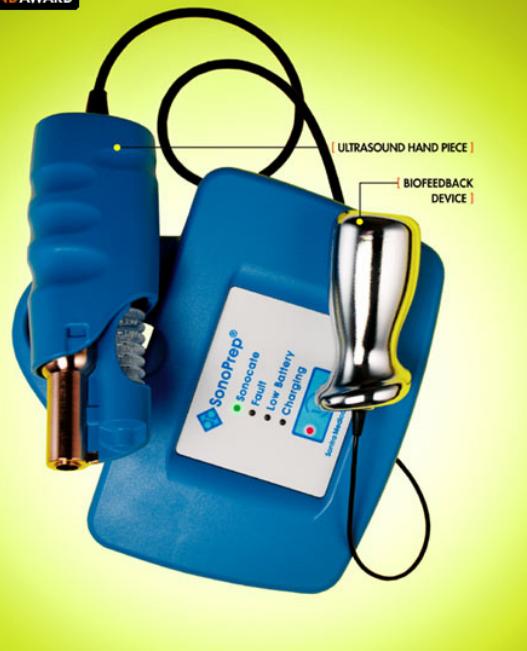
POPULAR SCIENCE

best
of
what's
new

2004

SonoPrep Skin Permeation Device
Injecting drugs with acoustics—not needles

GRAND AWARD



SBIR: SonoPrep
Needle-less drug
delivery for vaccines
-- future battlesuit



ATLAS / Nate Ball:
MIT-Lemelson \$30K
Inventiveness Award;
PBS Design Squad;
Army Rapid Equip Force
\$120K Procurement of
ISN SDC-award winning
ATLAS Powered
Rope Ascenders
-- current needs

<http://wbztv.com/video/?id=29313@wbz.dayport.com>

www.atlasdevices.com

ENABLING RAPID VERTICAL MOBILITY



Address E

PBS GO! DESIGN SQUAD ZINES & THEMES SHOW & CAST

Watch the shows, meet the cast, and scenes stuff. And keep your eyes p to come!

SHOW & CAST

WATCH THE SHOW MEET THE CAST

SHOW #1 THE NEED FOR SPEED

A screenshot of the PBS Design Squad website's "SHOW & CAST" section. It features a "WATCH THE SHOW" button with a thumbnail of a person, a "MEET THE CAST" button with a grid of cast member photos, and a "SHOW #1" thumbnail with the title "THE NEED FOR SPEED".

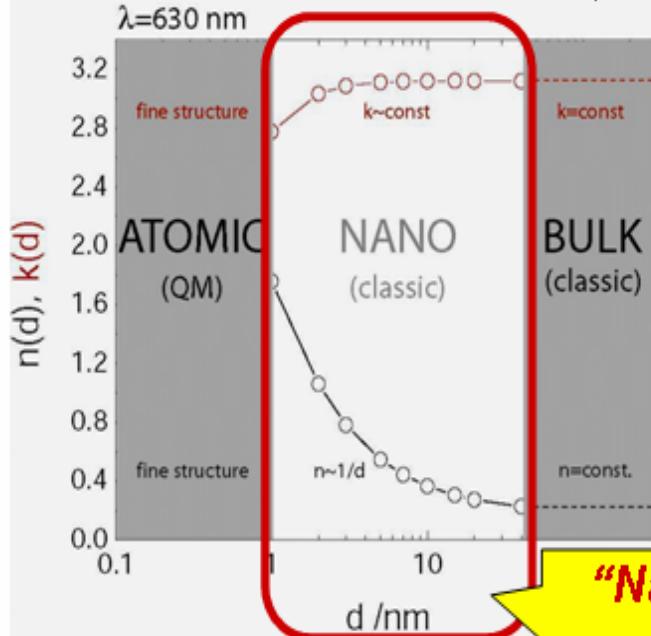


ISN: Building Understanding of a New Class of Materials with a Human Customer in Mind



Size Effects on the Optical Properties of Gold:

Plotting the Index of Refraction of Gold shows
 $n + ik \rightarrow$ both n and k become size dependent



"Nano" == Where things change

Opportunities:
Understand the physics better

– new design space, new tradeoffs....



Characterize properties and Explore MANY uses of these new materials



*Define Parameter Space of new nanotechnologies -
Don't target a single specific application*



Soldier Capabilities Enhancement: Technology from the ISN This Decade



Improved Performance:

- 'Exomuscle' actuators
- Situational Awareness (SA) from Quantum Dot thermal detectors & conformal computing displays

Improved Protection:

- Sense unseen threats: chem/bio
- Nano-enhanced protective Materials (Transparent Armor, flexible protective materials)
- Smart coatings
- Smart materials with dynamic, switchable surfaces

Improved Soldier Capability:

- Soldier bio-med: far forward triage & treatment (Needle-less drug delivery, dynamic splints...)
- Give individual Soldiers *small-unit* capabilities: Ubiquitous sensors, SA...



Improved Development Tools:

- Advanced Modeling & Simulation
- New Materials Characterization, Design and Test Tools
- Nano manufacturing

Broader Enhancements

- Nanoscientists work for Soldiers
- Nano-systems engineering know-how
 - Commercial Apps for Soldiers, First Responders (via Industry Partners, Small Businesses, Soldier Design Competition)
 - Unexpected advances

Improved Military Capabilities:

- Improved Armor Materials
- Lightweight materials for Army systems (Vehicles, weapons, etc.)
- Advanced Materials + Optical Properties
 - Laser Detection Sensors

** Army Collaboration

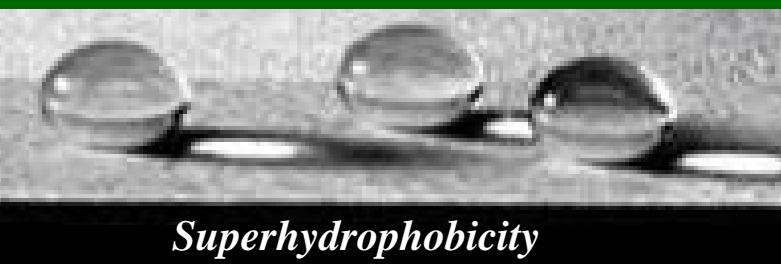


New Materials: Biomedical Electrospun Scaffolds

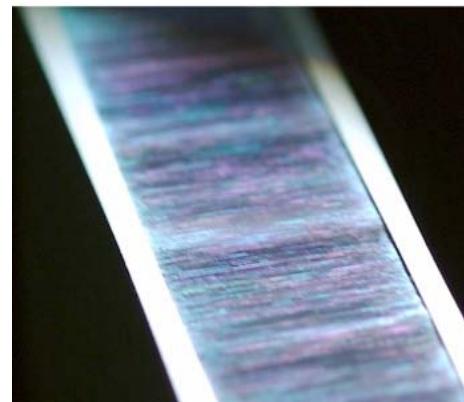


- Project 4.4 partners Prof. Gregory Rutledge's team with Dr. Sonya Shortkroff (BWH and CIMIT)
 - Exploring electrospun PCL scaffolds to grow new biological tissues such as chondrocytes

Electrospinning & Polymer Nanofibers
(L. Chen, J.L. Lowery, M. Ma, M. Wang,
KK.Gleason, RM.Hill /DCC, D.Kaplan, S. Shortkroff)

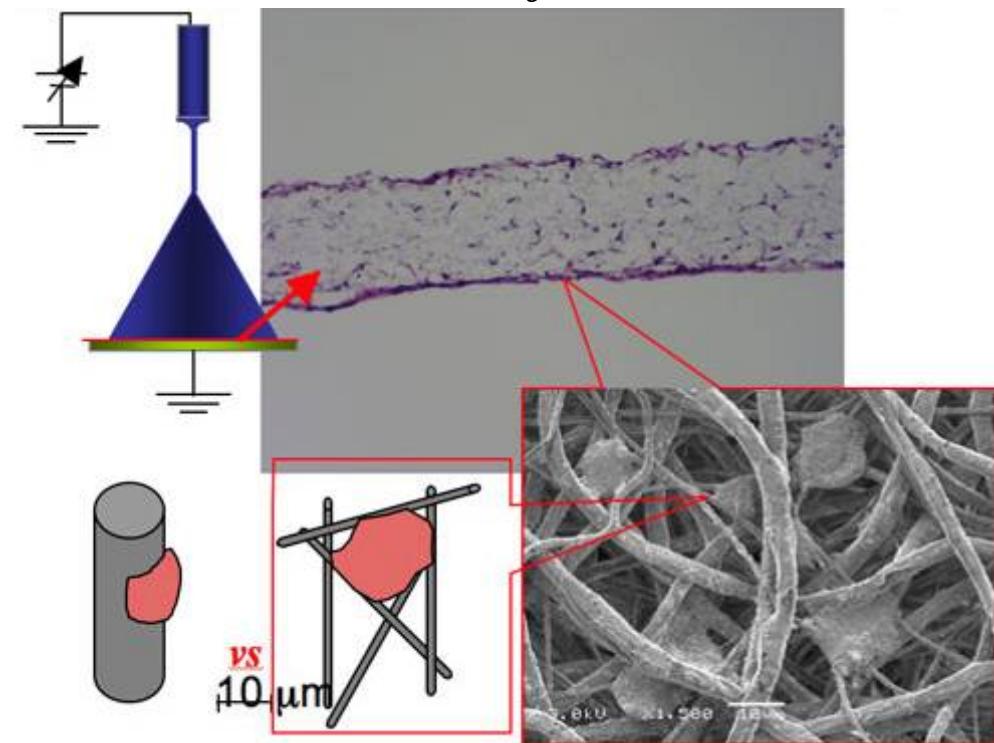


Superhydrophobicity



With R. Hill, DCC
Visiting Scientist
@ ISN, Rutledge
group co-invented
monodispersed
color-shifting
nanofibers

*Electrospun scaffolds exhibit
unconventional cell/fiber interactions*





Collaboration between ISN researchers and Army Scientists: On-Site Army Research Lab (ARL-WMRD) Scientist



- Interesting material system developed at ISN
 - ➔ Army Scientist Alex Hsieh creates transparent armor, understands Army context
 - ➔ ISN researcher Jian Yu created a polymer system with embedded nanofibers
- Initial goal leads to transition opportunities:
 - ➔ Initially: reinforce eyewear
 - ➔ Discovered *interesting optical properties in UV*
 - ➔ Many potential applications (*optical tagging*):
lead users for feedback / testing....



Optically transparent
in visible light



Pattern detectable
under UV

Army Scientist Alex Hsieh + ISN researcher Jian Yu

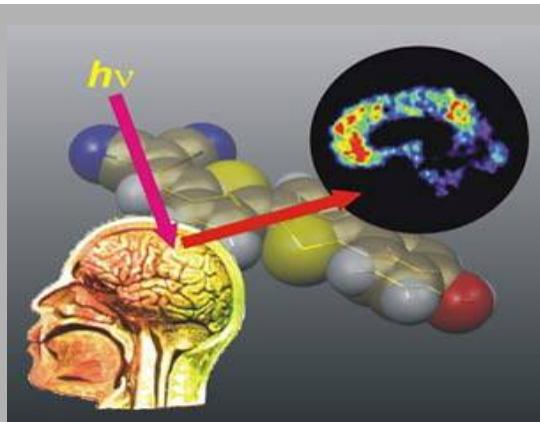




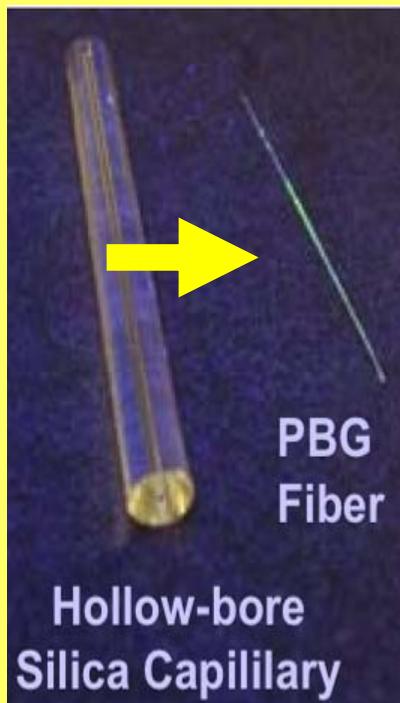
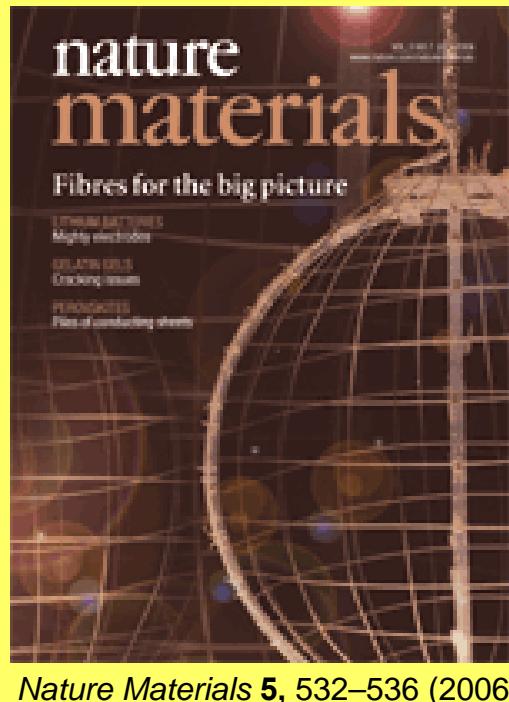
ISN Tech Insertion: Army-funded 6.1 & 6.2 Science continues to improve explosives detection, leading to other capabilities



Extending chromophore use:
from finding explosives (FIDO) to finding Alzheimer's:
Swager's group designed new dye (NIAD-4) to bind with brain plaques (TBI?)



Changing chem platform: Swager / Bulovic / Fink



**Hollow Photonic Band Gap (PBG) Fiber:
Smaller Size & Better Signal**

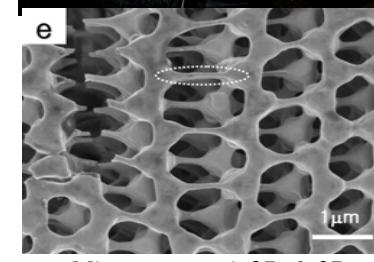
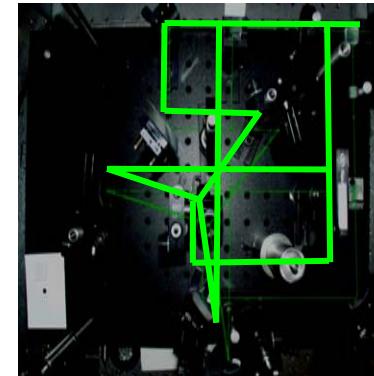
Nomadics FIDO == PLATFORM technology to insert new capabilities



Future Developments... Information-bearing Protective Materials?



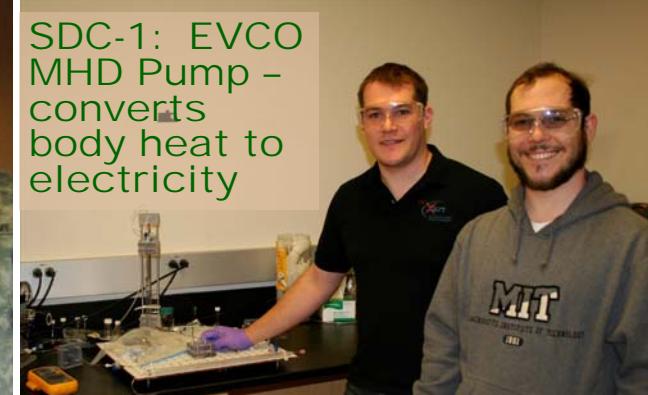
- Possible structural materials:
 - + Next-gen Light-transmitting polymer (fiber optics inside polymer matrix)
 - ➔ CNT-reinforced polymer matrix
 - ➔ Embedded FiberWeb fiber sensors
- Possible protective materials:
 - + 3D Microtruss system
 - + Holographic Data Storage
 - DCC subsidiary Aprilis
- Micropumps + FiberWeb == lightweight laser warning systems, systems (OPTICAL SOUND) etc...
- Lens-less Imaging with FiberWeb
- Flexible EMI Shielding with iCVD
- New computer interfaces: logistics ops



Microtrusses via 2D & 3D photolithography



LitraCon
light-transmitting concrete invented by Hungarian architect Áron Losonczi – Structural material embeds optical fibers
www.litracon.hu





Army Expectations of Industrial Partners



Focus: Nanotechnologies to improve Soldier protection

- Industry Partners should support Soldiers as valued customer
 - Collaboration with Army/DoD S&T encouraged
- 6.2 Research should be scientifically compelling, AND should lead to commercial applications for nanotechnologies, leveraging 6.1 basic research
 - Two major paths:
 - Commercialize for open market; Army / other Gov't == Customers
 - With Army programs, customize for applications for the Soldier
 - Seek ways to expedite transition into products
 - Early products may be incremental improvements over current tech

→ Soldiers = *Lead Users*, giving feedback on future directions

Raytheon

DUPONT

PARTNERS
HEALTH CARE

DOW CORNING

JEOL **NOMADICS**

CNI

dnt
the dendrimer company
zyvex

GORE
Creative Technologies Worldwide

MSA

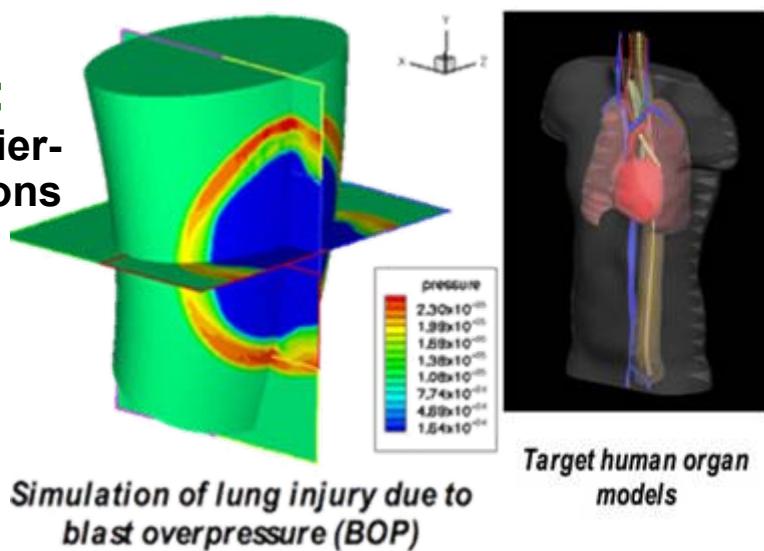
Honeywell



Army-funded University Affiliated Research Centers work with Army Scientists to address challenges



Energy Absorption: Modeling Soldier-Blast Interactions *Radovitzky*



Simulation of lung injury due to blast overpressure (BOP)



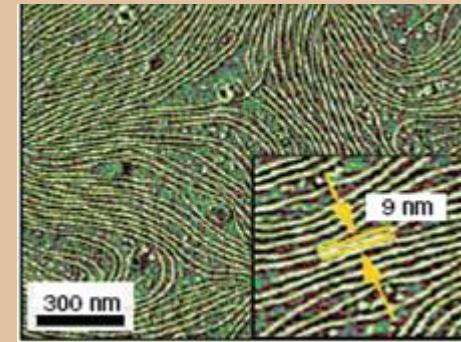
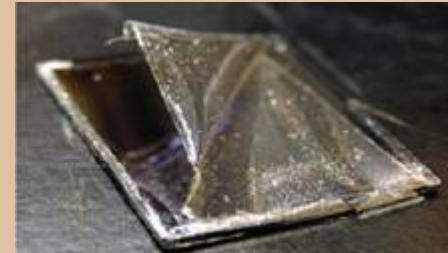
Army ARL-WMRD
@ISN: Scientist
Alex Hsieh



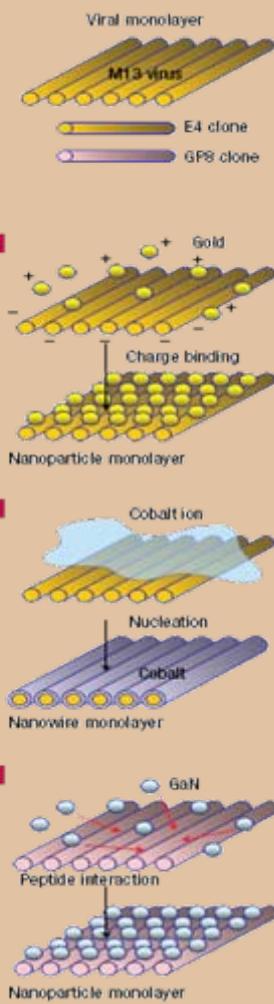
Transparent Protection:
Shear Thickening Foam system,
tested at ARL-WMRD

Portable Energy: Virus-based Self-assembly of flexible Lithium batteries

Belcher, Hammond, Chiang



Nature Materials, Vol 5, Mar 2006





SDC Transition: Ancile Warning System



Cadets 1st Class Brian Lebiednik and Greg Isham (front center and right) smile as Ancile system picks up another mortar round at the C-RAM exercise at Yuma Proving Grounds, AZ. Army officials said they hope to issue pagers to Soldiers in Iraq within the next nine months. *U.S. Army Photo*

Reward Innovation for Soldiers!

“Cadet project could save lives”

By MAJ Fernando J. Maymi, D/EE&CS

“Pointer View,” May 27, 2005

<http://www.usma.edu/PublicAffairs/PV/050527/project.htm>

Four senior USMA cadets helping make troops safer.

EECS senior project for USMA Cadets 1st Class:

Jeffrey Hermanson, Jamie Dayton, Brian Lebiednik, Gregg Isham
Cadet team designed and built an Ancile pager
to warn Soldiers of incoming artillery/mortar strikes

Army tested at Yuma PG: “significant advance notice each time”

Project sponsor Paul Manz, technical director for ground combat command and control in Fort Monmouth, NJ, developed a plan to field pagers within 9 months.

Their senior project was a great way for them to help Soldiers:

“wonderful that we were able to do something that helps keep our fellow Soldiers safe while they are working to keep us here at home safe”

**→ Florida-based Mahdahcom
licensed + is producing Ancile**



Dealing with Success: Innovation Challenges

Secretary of the Army joined us for ARO @ ISN Workshop, 11 Apr 2006



- In innovation, tech **availability ≠ adoption**

- Absorptive capacity issues
 - Practice for major change (FCS)
- Clockspeed differences
- Impedance mismatch



- Outsourcing risk == outsourcing process

- Other peoples' processes reward differently
 - MIT TLO → patenting IP, \$\$\$
 - Small business marketing needs vs. OPSEC



- Entrepreneurs need to survive

- First customer == favorite customer
 - Lead users: joint, varied missions
 - Champions crucial
- Timelines are very different!!
 - RallyPoint: Apr 2004 vs. FFW Dec 2007



Good challenges to have...



- Need to help manage risk

- Army can help! Eg, Safety Certs, operational assessments
- Need business growth: shared costs / revenues

- Innovation can help the Army & the Army can help innovators!

- Need adaptive leaders who train in innovation
 - Science must translate to technology
 - Technology must come to market
 - Customer purchases make a difference

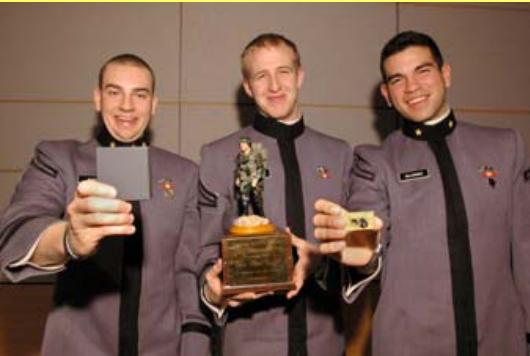




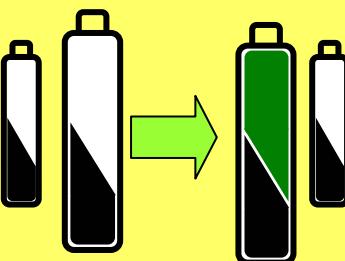
Support to Current Operations



- Nomadics FIDO explosives detector has been in Iraq since Summer 2004: limited assessments by Soldiers and Marines, and screening with EOD Tech
 - ➔ Detects TNT/TNT-based explosives, usable in several modes: handheld, on robot, underwater, down wells
 - ➔ Air Force bought systems for cargo screening
 - ➔ Army Rapid Equipping Force and Joint IED Task Force funding Iraq-based ATEC *Warfighter Assessment* of integrated FIDO on iRobot PackBot for vehicle inspection
- PEO Soldier procured ISN Soldier Design Competition award-winning Battery Power Scavenger designs from undergraduate teams for Soldier assessment
 - ➔ Designs from Supercharged (USMA) and Xitome (MIT) help Soldiers by scavenging power from used AA batteries for rechargeable batteries



USMA Team Supercharged: Cadets Nick Barry, Jeremy Spruce, Walter Velasquez



MIT: Xitome CEO Kailas Narendran shows PowerPlus



Election Day 2005:
Al Kasic, Iraq –
Nomadics SME: Brian
Heishman screened with FIDO



ISN "Fiber Web" linear sensors (Profs. Fink & Joannopoulos)



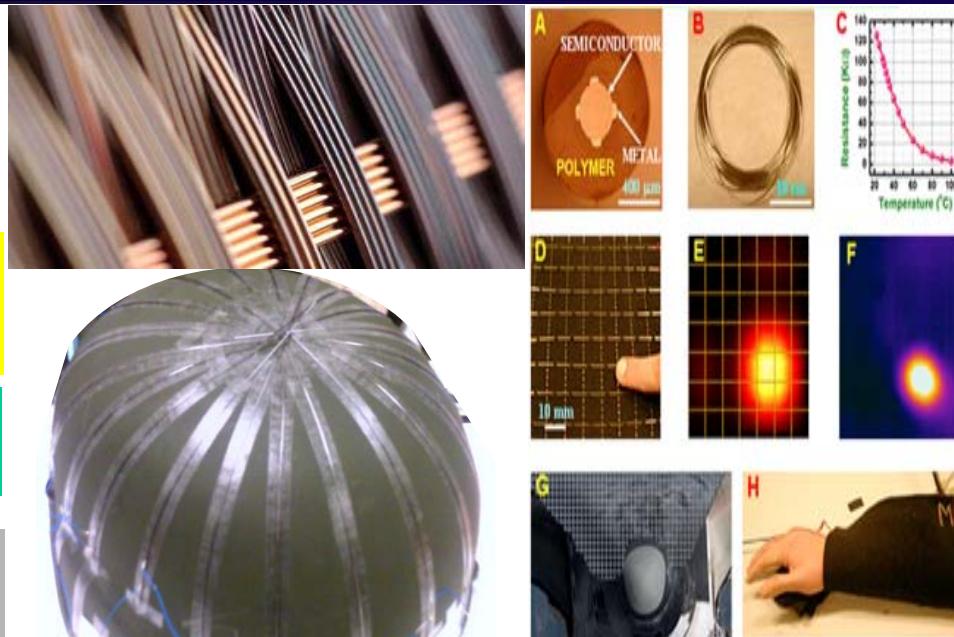
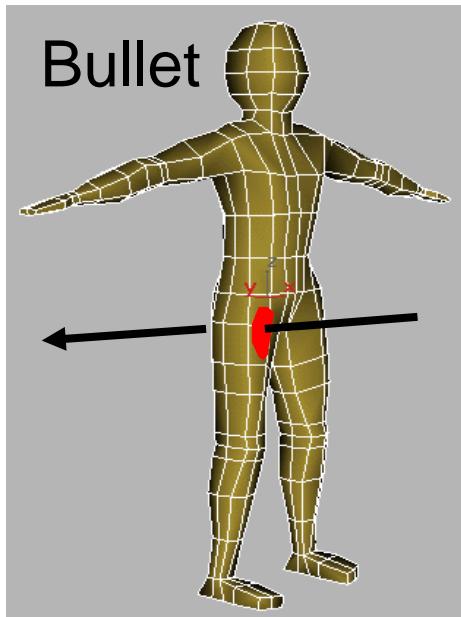
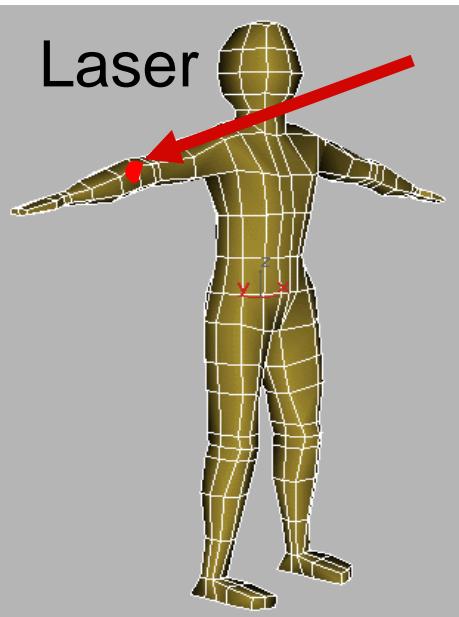
Same Material: FIBER WEB:

*Senses light from lasing
(both ops + embedded training),
Temperature for well-being,*

*Lasers for intra-squad comms
(when RF not available or desired)*

**Full Body MILES++
For Realistic Training**

**Full Body Thermal
Sensing**



-- Rapid helmet prototype for
PM SOF Warrior CID user demo
27Nov2006

-- Based on 20Dec2006 VTC,
PM Live Training Systems will assess
for potential use in
Training devices e.g. MILES, E-Targets
Challenge: Tech vs. OPSEC



- Why ISN good idea: ISN acts as hub
 - Multi-dept professors brought together
 - Chem Eng (Gleason) + Chem (Klibanov)
 - Big discoveries at the crossing of academic boundaries
 - Army benefits from interaction of smart people
 - They benefit by meeting / knowing customer
- My role: Military liaison – people get immediate feedback from me as combat commander on technology uses
- Some ISN projects
 - FIDO
 - Cima Microchips vs. hemorrhagic shock --??
- My special project
 - FiberWeb ICOM-H: comms over light
- SDC rapid innovation program: How are we helping the Soldier today

Breakthroughs, the Product of Innovators

By Burt Rutan



Breakthroughs: Why

- Technical accomplishment
 - Defines our species - separates us from other animals
 - Satisfies desire for continuous improvement
 - Provides for ‘well being’
- Without breakthroughs
 - Boredom and mediocrity
 - Low expectation of future
 - Degradation of national security

Breakthroughs: When

- When do breakthroughs occur?
 - During or shortly after:
 - Crisis, chaos, “bad” times
 - Not:
 - During tranquil, stable, “good” times
 - When highest priority is equal status of populous
- We are creative when scared

Breakthroughs: How

- Breakthroughs cannot be specified by massive funding
 - Example: Low cost space access was the **goal** of the Space Shuttle Program
- Breakthroughs occur due to the working environment
 - Kelly Johnson ‘Skunk Works’

Breakthrough Observations

R & D experience has **inverse** relationships

- Value of product....Self-perceived sophistication of customer
- Content of new technologies....Program timeline
- Product's worth....Risk averse role of managers

The management of innovators

Manager's only tasks: Set goal and get funding

- Set goal high (50% should say impossible)
- Reward achievement of goal (power of a prize)
- Let the innovator decide what risks to take
- Leave them alone and keep others out
- Applaud courage and expect multiple failures
- Allow *fun*

Focus for the management of innovators

“If you want to build a ship, don't drum up people to collect wood and don't assign them tasks and work, but rather teach them to long for the endless immensity of the sea.”

-Antoine de Saint-Exupery

Exposure During Childhood Leads to Adult Technical Innovation

- Inspiration begins early – Kids ages 3 to 14

Our Responsibility Now - Create Progress to Inspire our Kids

- Our Technology leaders had their inspiration in exciting times
- Periods of extreme technical progress:
I will discuss three.
 - Aviation's Renaissance, 1908 to 1912
 - My inspiration, 1946 to 1957, post WWII
 - Gagarin to Skylab, 1961 to 1973

Aviation's Renaissance

1908 to 1912

- Early 1908, < 12 pilots
 - Then “I can do it”
- By 1912
 - Hundreds of aircraft types in 39 countries
 - Aircraft invented by ‘Natural Selection’
 - Airshows with 400,000 attendance

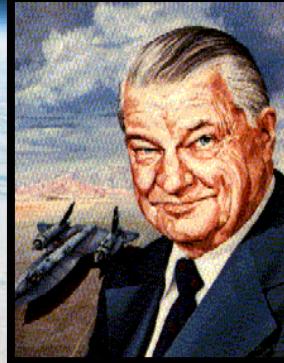
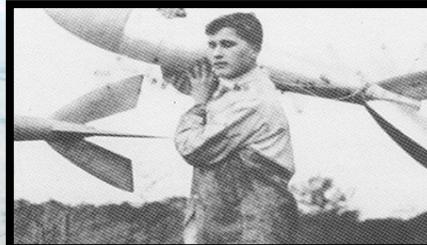


Kids Were Inspired by Aviation's Renaissance



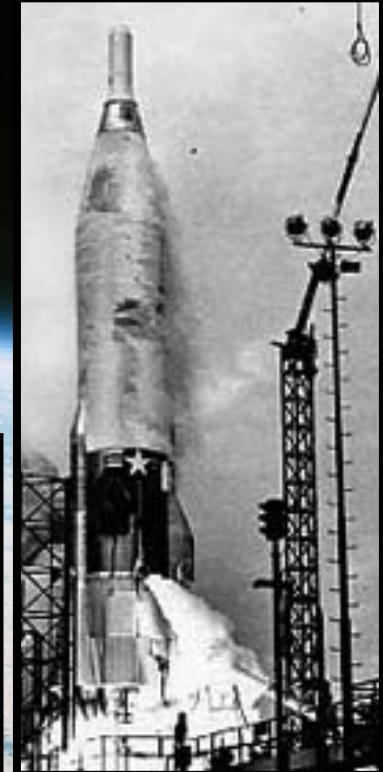
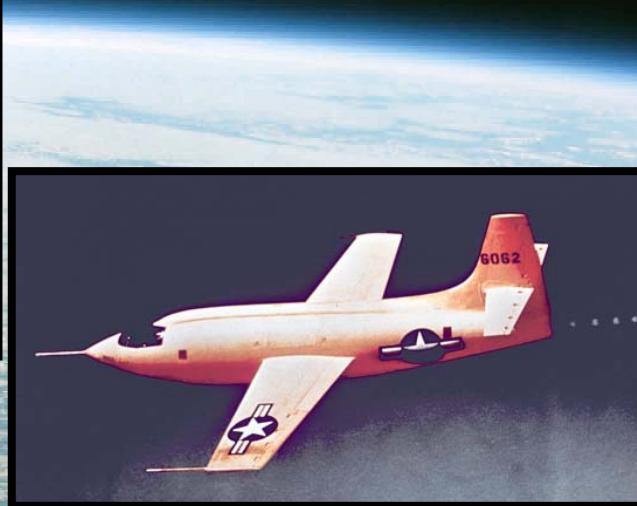
Which Kids Were Inspired by Aviation's Renaissance?

- **Every one** of those that inspired me.
 - Wernher von Braun
 - Kelly Johnson
 - Charles Lindbergh
 - Jack Northrop
 - Ed Heinemann
 - Howard Hughes
 - Sergei Korolev
 - Alexander Lippisch
 - Bill Lear



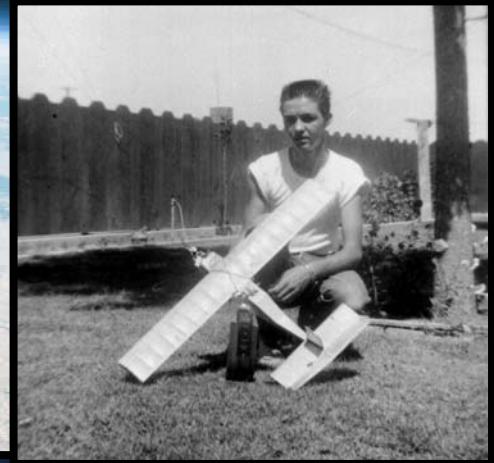
Aerospace Activity 1946 to 1957

During my Childhood (age 3 to 14)

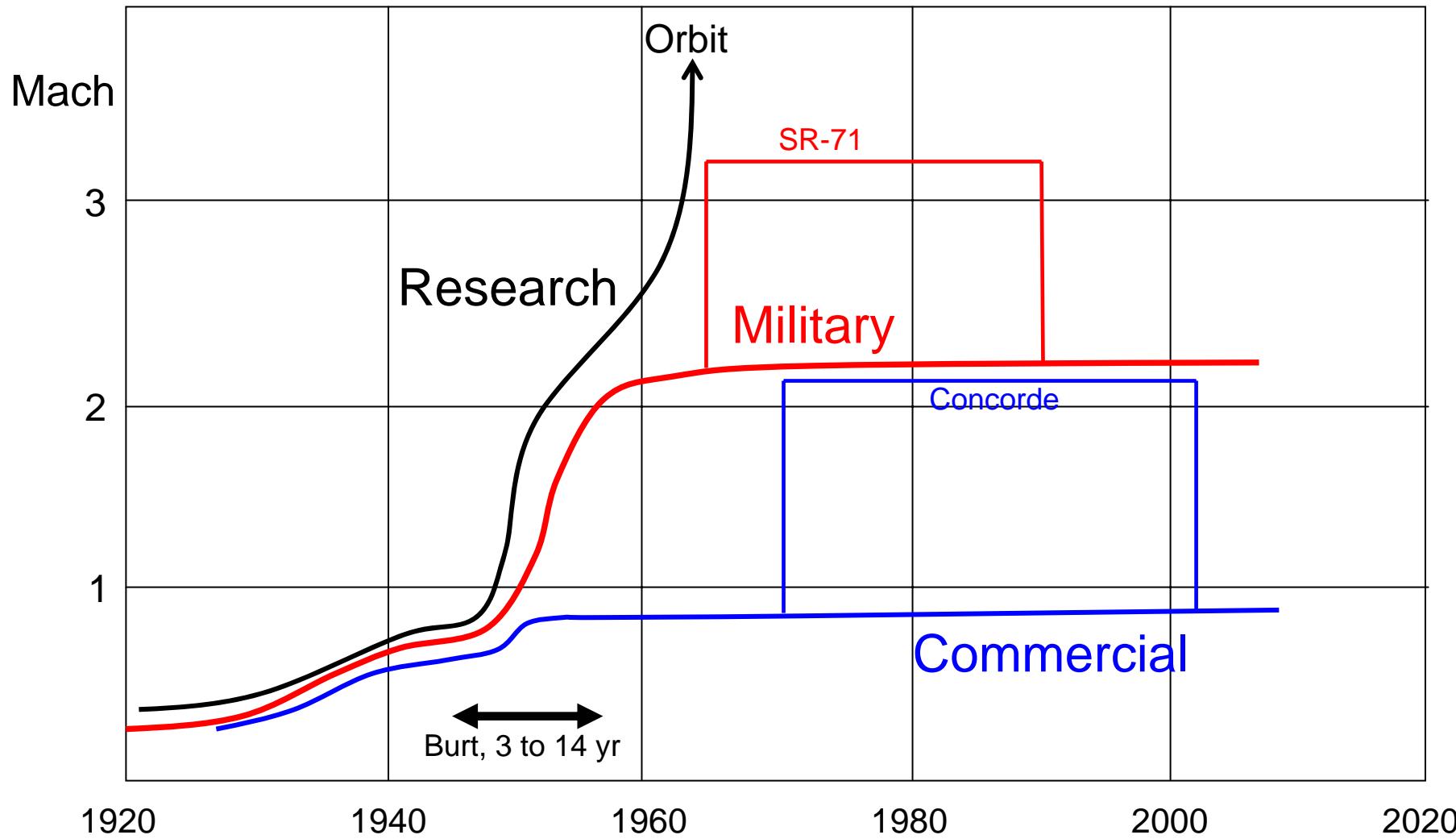


The Jet Age starts. The Missile Age starts.

Childhood Activities Were Driven by Aviation Progress



A Jump in Performance Inspired me during childhood



My Post-College Career Choice: Aviation (unusual for space-crazed 1965)

- Airplanes, not the moon
 - Realist?
 - Burt the conservative?
- General Aviation was the passion, but Air Force Flight Test, was the Compromise.

Air Force Flight Test 1965 to 1972

The “whole-package” experience

Best training for an aircraft designer



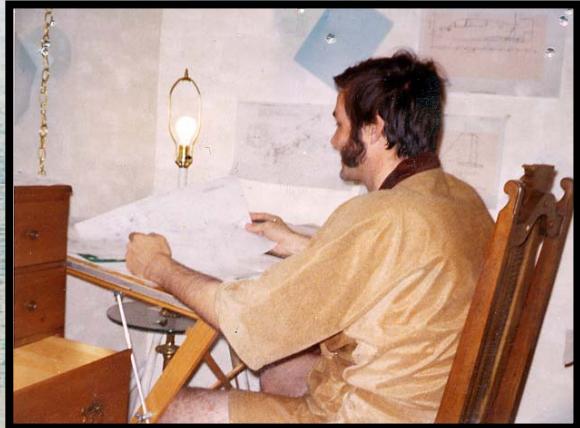
Military Flight Test Not Fulfilling

- Great experience, but not creative
- Light aircraft – target rich for innovation
- Light aircraft were the ‘fun hobby’
- The dream of a job as fun as the hobby

A Big Jump 'Down' 1972

Rutan Aircraft Factory

The entrepreneur can control his destiny

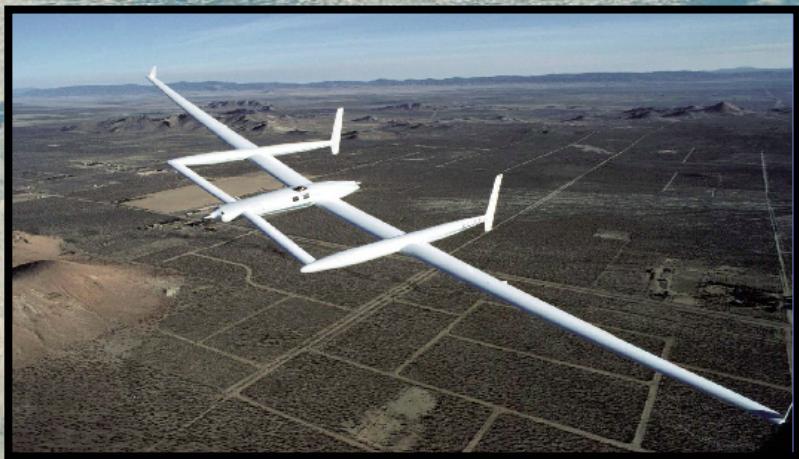


The Projects of RAF 1972 to 1985



The Public Interface

The Thrill of the Milestone



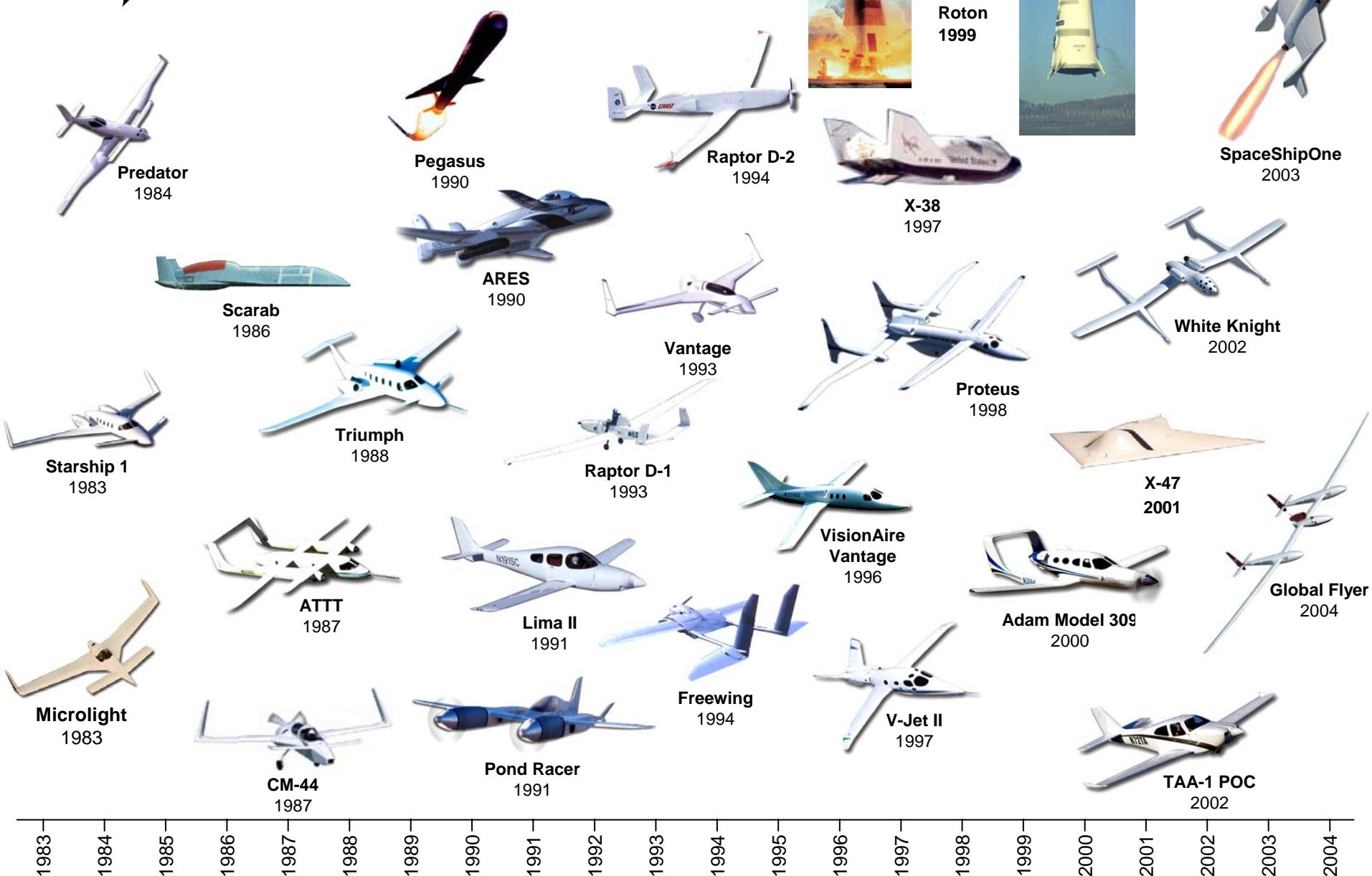
Scaled Composites Company

1982 - Present

- Composites Structural Technology
- Aggressive projects, big customers
- World-Class Staff – shop and engineering
 - More folk to have fun



Scaled's Aircraft



Why The Perfect Accident Record?



The U.S. Manned Space Renaissance

1961 to 1973

- Progress accelerated by Sputnik/Gagarin ‘losses’ – The need to regain National prestige
- A wild ride to recover prestige
 - Mercury, Gemini, Apollo lunar, Skylab and planetary exploration
- Enormous courage applied to huge risks
 - Five launch systems in seven years
 - Apollo 8/Saturn 5 risk
 - Lunar-orbit-rendezvous decision

American Manned Launch Systems

Redstone

Atlas

Titan

Saturn

Shuttle



Flights: 2

4

10

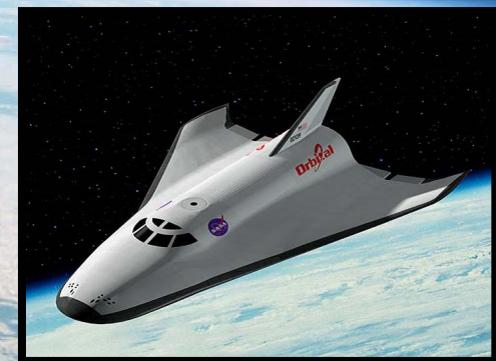
15

114

Each was abandoned when more expensive one became available - not matured for affordability

The Collapse that Followed 1973 to Present

- Abandoned genuine search for safe, efficient orbital manned capability.
- Abandoned lunar capability
- Risk-averse attitude: study it, do not try to fly.
- Lacked the courage to fly new research programs



The Most Impressive Aircraft? Lockheed SR-71

Designed in 1959, only 14 years after first operational jet.
First flown in 1963.
Abandoned in 1998, retreated to 1956 U-2.

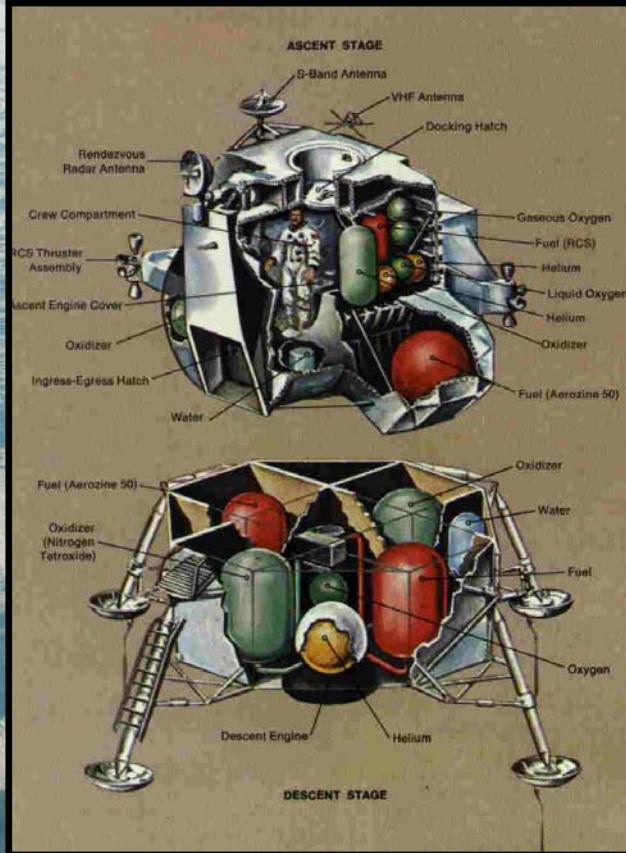
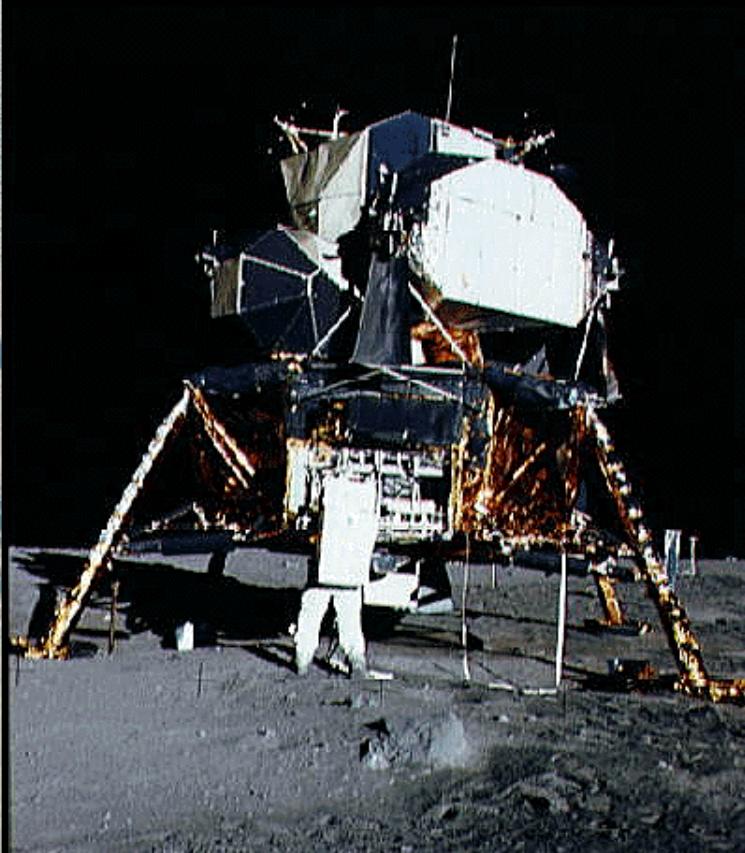


P-80
1945



The Most Impressive Spaceship?

Grumman Lunar Module
Designed in 1964, three years after Gagarin
First flight 1968
Abandoned capability in 1972



What is wrong with this picture?

1925



PictureHistory

1965



2005



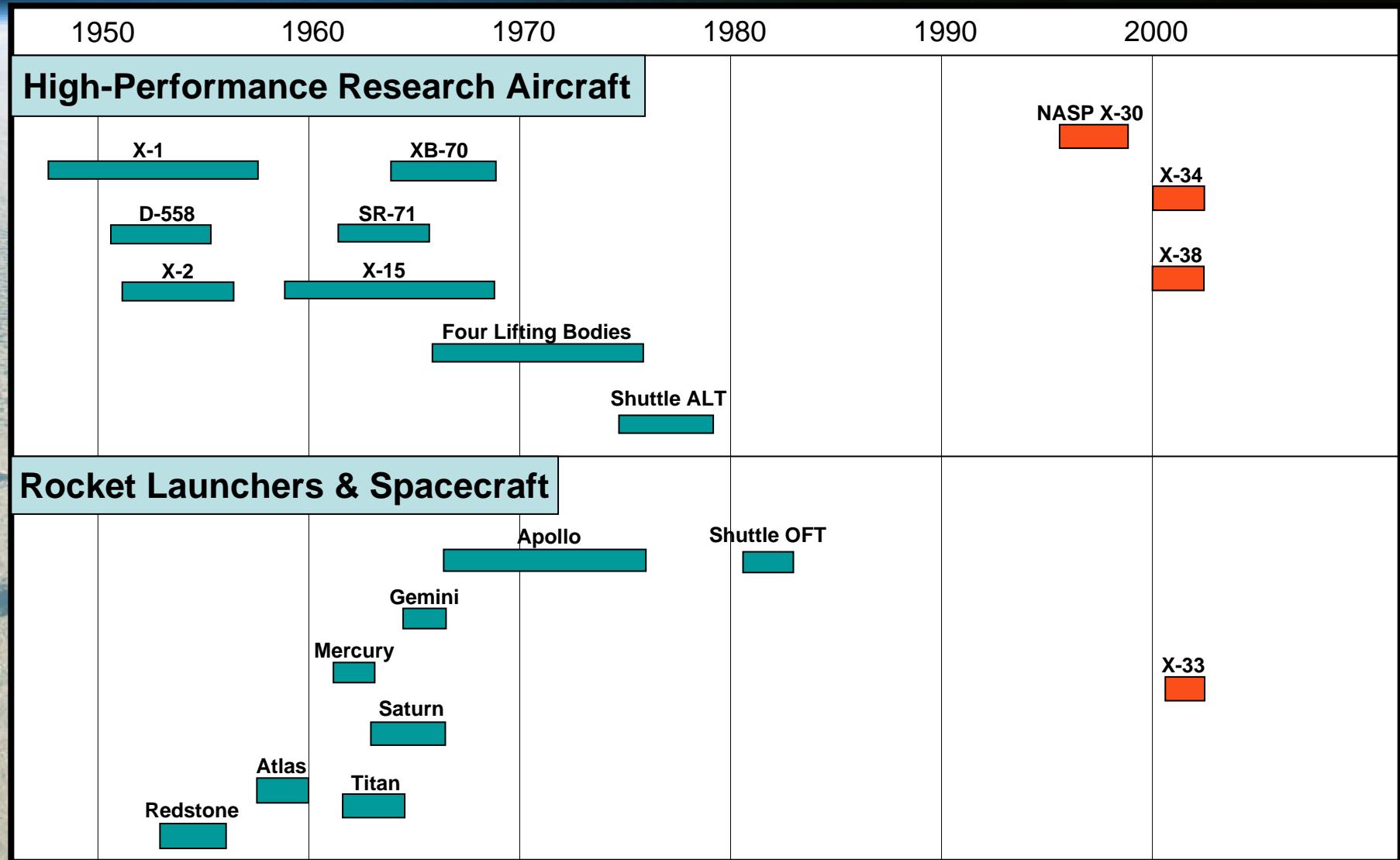
F-22 Raptor & F-35 JSF

The only new USAF fighters for the next 40 years?

- Another 40 years with 1960's performance?
- Requirements based on perceived need, not a desire to find performance breakthroughs.
 - Air superiority in < 2 days, last two decades.
- Requirements direct Development Programs, not Research.
 - Industry employs a new generation of aerospace engineers who think development **is** research.
 - Risk averse requirements breeds risk averse technical progress.

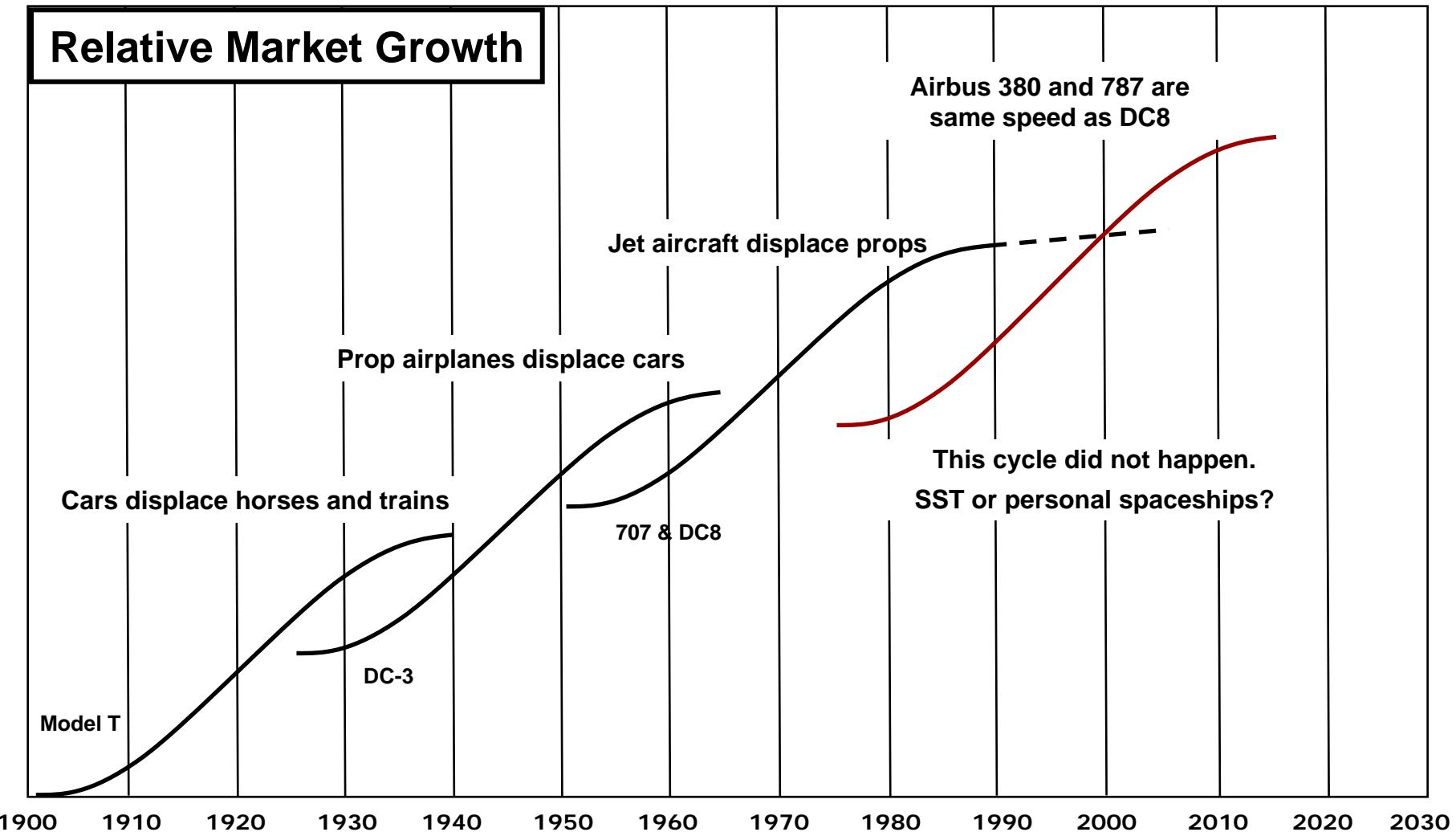
Historical Perspective

Manned Research Programs That Expanded the Envelope



Higher Speed Travel – Forty Year Cycles

We are Overdue - Recent Cycle is Missing



Orion/Ares, NASA's road ahead

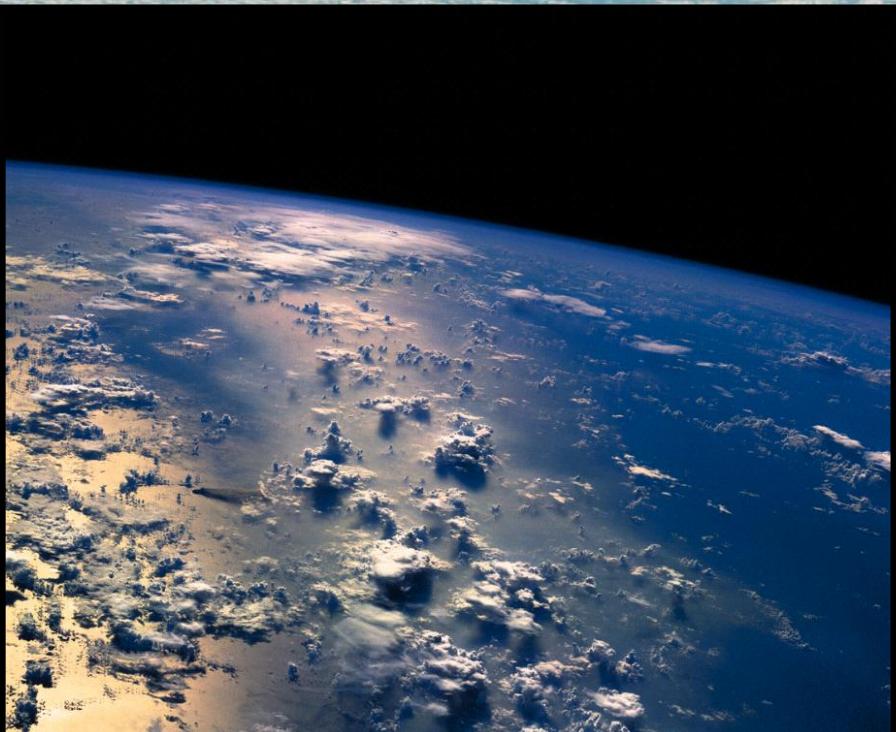
- Retreat to Apollo/Shuttle-era hardware for manned orbital and lunar operations
- No opportunity to discover breakthroughs
- Another 13 years without progress for Personal Spaceflight
- Lack of challenge for another full generation of spacecraft designers.



Our Sub-Orbital Space Program

The Goal is Fun, To Enjoy This View

To stimulate a Private Spaceflight industry,
so others can enjoy this view



Space, for us – Why Now?

- SpaceShipOne was a personal goal, not a customer request
- Inspiration from visionaries' courage
 - Required my exposure **as a child**, not a view of current aerospace practice
- The 'New Space' investors/developers – were, **as children** inspired by Sputnik to Apollo
 - Allen, Musk, Bezos, Branson, Bigelow, Page/Brin & Carmack

Our Research Test Pilots



Launch Aircraft - White Knight

- Identical systems components to Spaceship.
- Provides pilot training for boost, entry & landing.



SpaceShipOne

Air-launched
Feathered entry
Runway landing

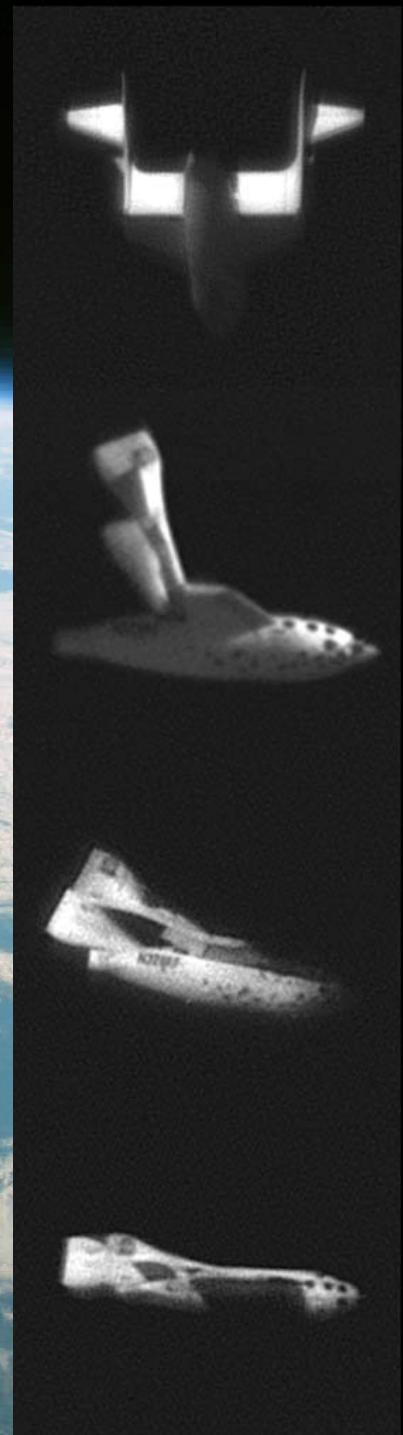
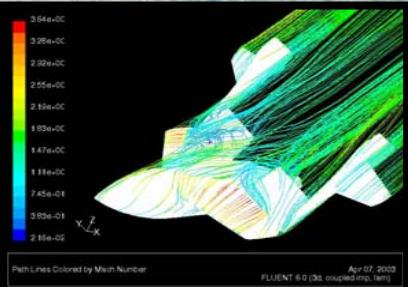


The Re-entry Feather

Immune to accidents caused by entry flight controls

Forces Ship to a Stable High Alpha Condition
Active controls not needed

- High Drag = Lower loads & Lower Heat
- Result: 'Care-Free' atmospheric entry



An Aggressive Flight Test Program



- White Knight , Pre-Spaceship
 - Performance, Stability & Space Systems Development
 - 56 flights, 10 Months
- Rocket Hot-Fire Ground Tests
 - R & D - nine months, eleven firings
 - Flight qualification - Three Firings

- SpaceShipOne Flight Tests
 - Two captive carry (one manned)
 - Glide tests - 7 glides, 4 months
 - Rocket Powered Envelope Expansion – 4 flights, last one >100km
 - X-Prize – 2 full-performance flights in 5 days



Space flight really **is** too dangerous

Airline experience as a model

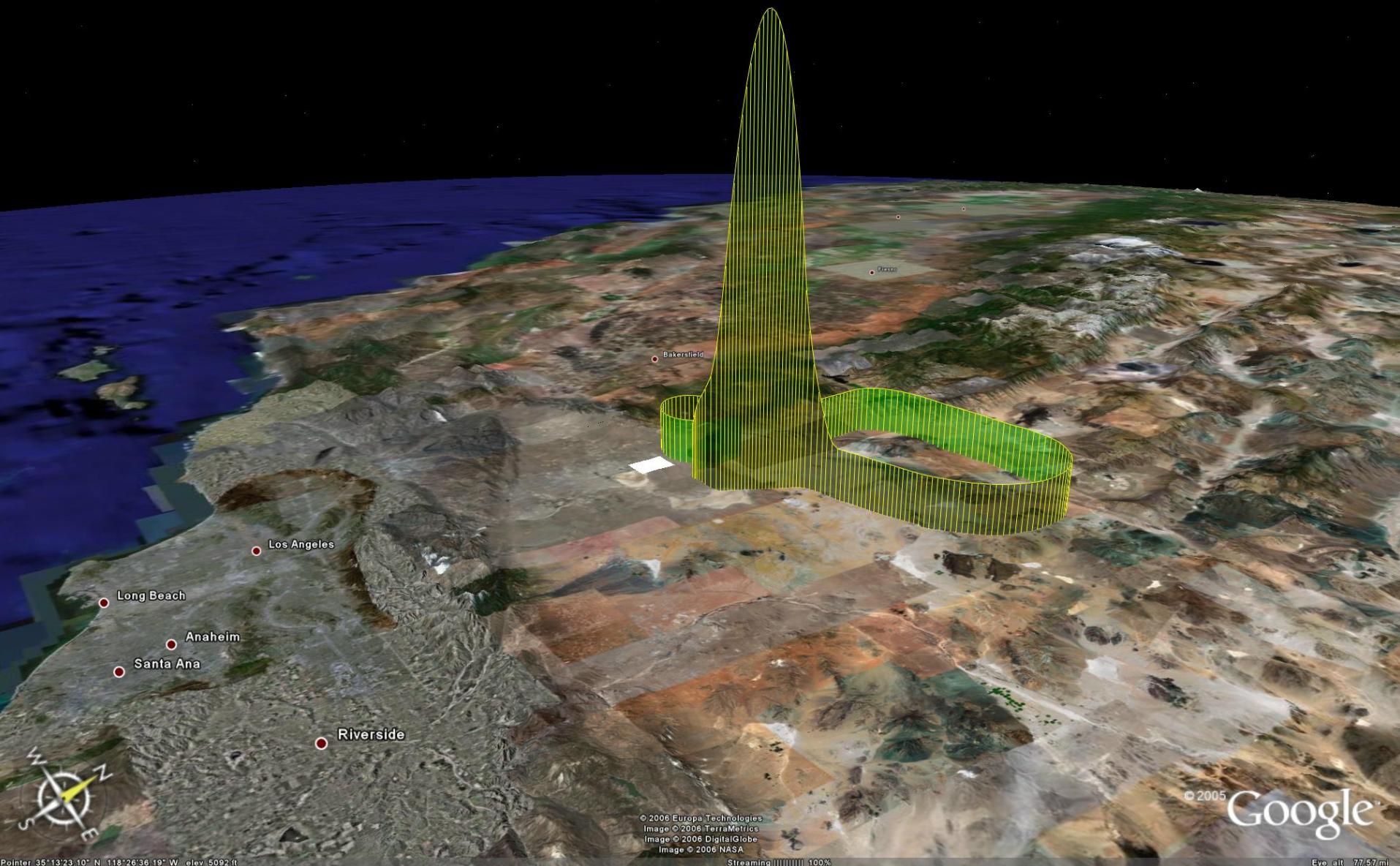
Risk statistics, fatal risk per flight

- All manned space flight = 1 per 66 flights
- First airliners (1927 & 1928) = 1 per 5500.
Same aircraft, but add some maturity (1933 to 1935) = 1 per 31,000
- Modern airlines = 1 per several million
- Logical Public Spaceflight goal:
 - Better than the first airliners
 - < 1% of the historic government space risk
 - Achievable only for sub-orbital

Is a New Space Renaissance Possible? What Is Needed?

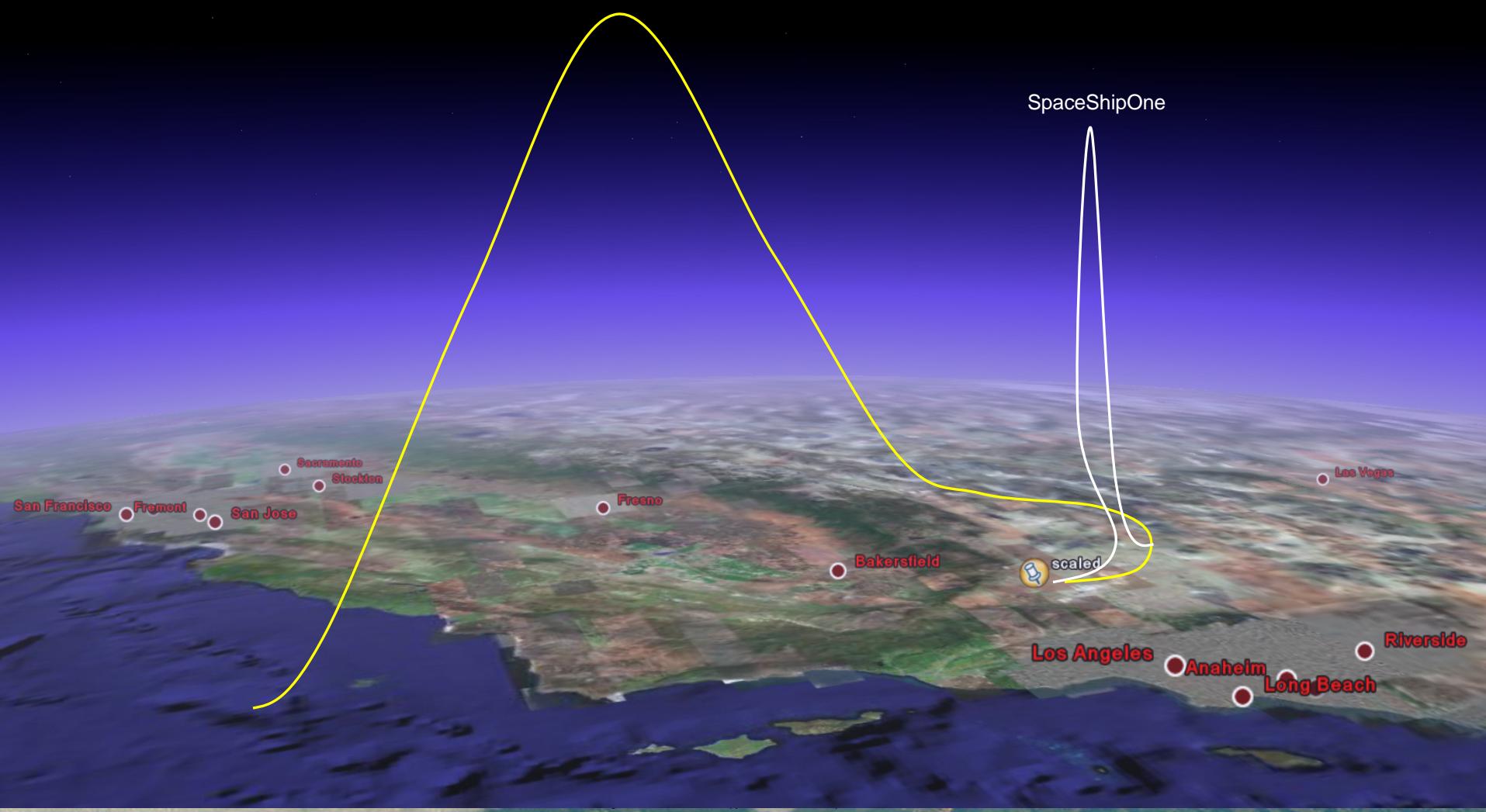
- **Environment that existed for aircraft in 1909**
 - Entrepreneurs in competition for market share
 - Belief that “I can do that”
- **Courage to try risky concepts**
 - Breakthroughs needed for safety
 - Robust solutions needed
- **Research justified by exploration and fun**
 - Not just politics and ‘science’

Your View from 130 Km altitude – Mojave Desert



Trajectories

Commercial SubOrbital Private Spaceflight



See the Islands from a different perspective....

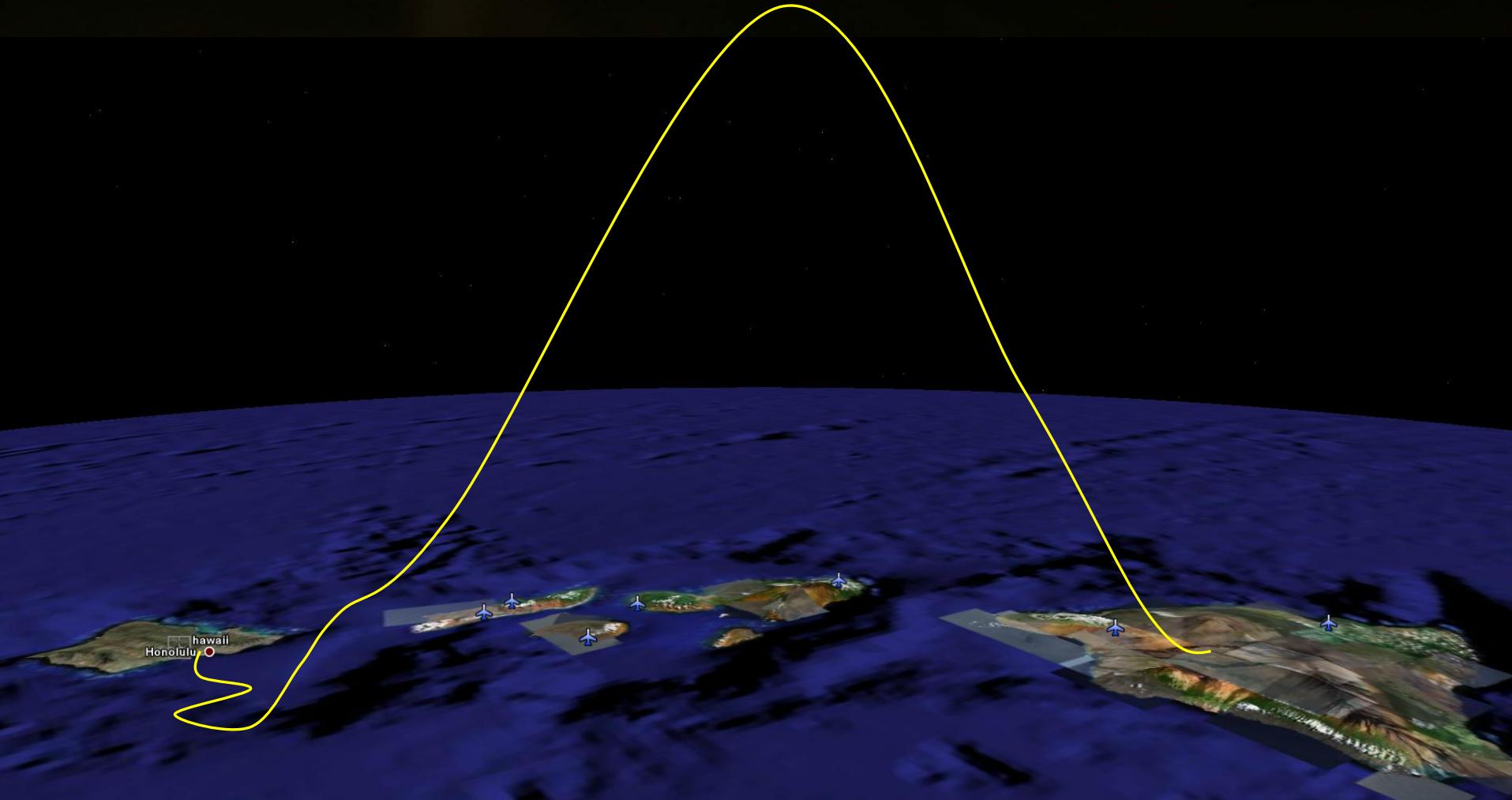


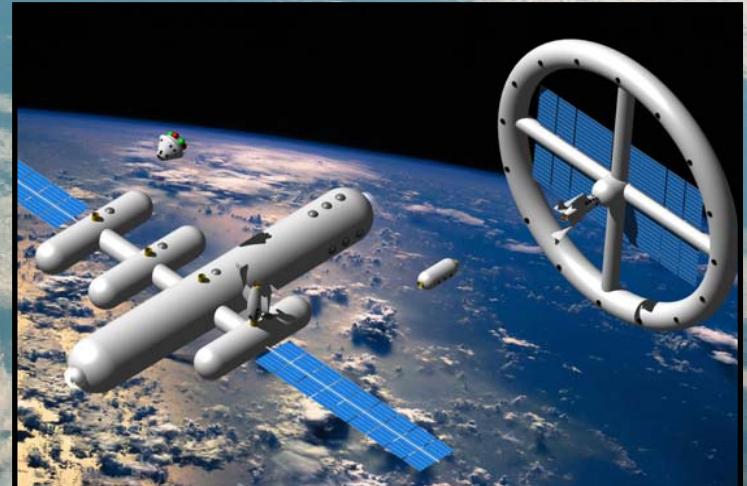
Image © 2007 NASA
Image © 2007 TerraMetrics
© 2007 Europa Technologies

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The Next Steps for Private Spaceflight

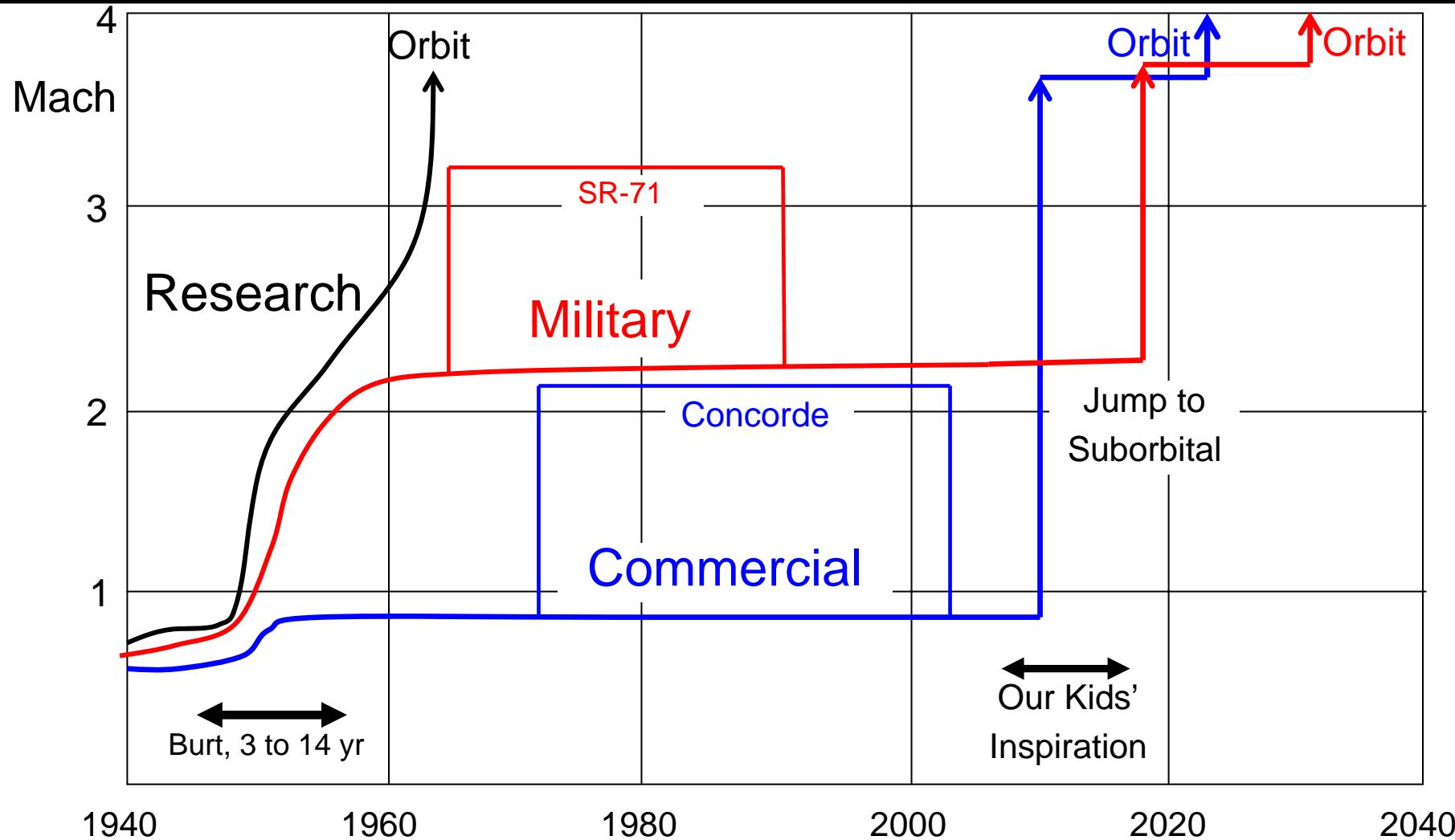
- First industry - sub-orbital flights
 - Experience – optimized
 - Large cabins, large windows and body weightless float.
- First industry - high-volume
 - Competing spacelines, flights priced to fly 100,000+ people (first 12 years of operations)

Success will accelerate solutions for safe, affordable flights to orbital resort hotels



A Prediction

Commercial Jumps Ahead of Military



What Good is a Private Sub-orbital Space Industry? Just for Fun?

- The home computer – Internet example
 - ‘Fun’ really **is** defendable
- Inspiration for kids
 - Today’s technology products are enablers, not goals
 - Kids need to be inspired by a far-out dream/goal

Why we stopped flying SpaceShipOne



Your request to a non-expert....

Rutan's Comments on S & T Focus for Defense?

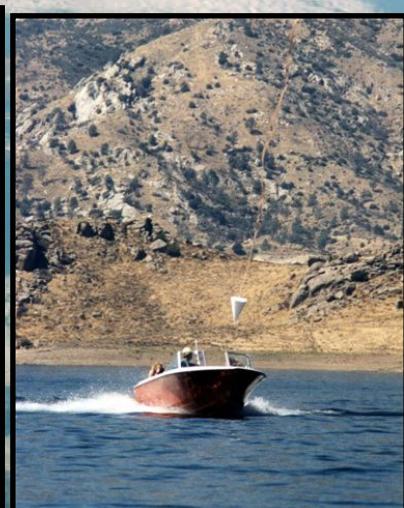
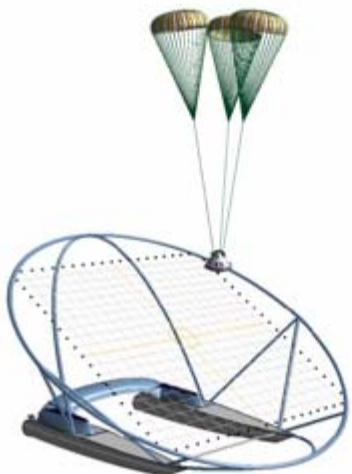
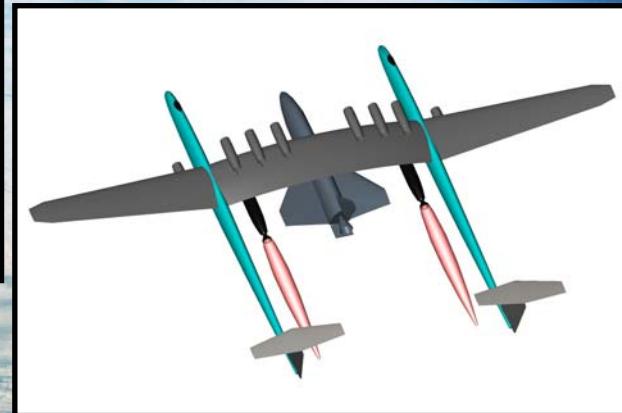
- U. S. competitive position in Science and Engineering.
- True responsive space presence.
- Heavy transport.
- The “all UAV Air Force”.
- Human contribution to global warming.
- Humanity's future in a connected world.

U. S. competitive position in Science and Engineering

- The education statistics are bleak
 - Science vs. lawyers/media/politicians/actors*
- * And other criminals
- The real reason – we are boring our youth
 - Development vs. research
- The solution – take real risks
 - Exploration
 - Adventure
 - Breakthroughs
- Strive to be great, not to be ‘equal’

True Responsive Space Access

- Air launch
- Routine, high-volume operations
- Sea recovery

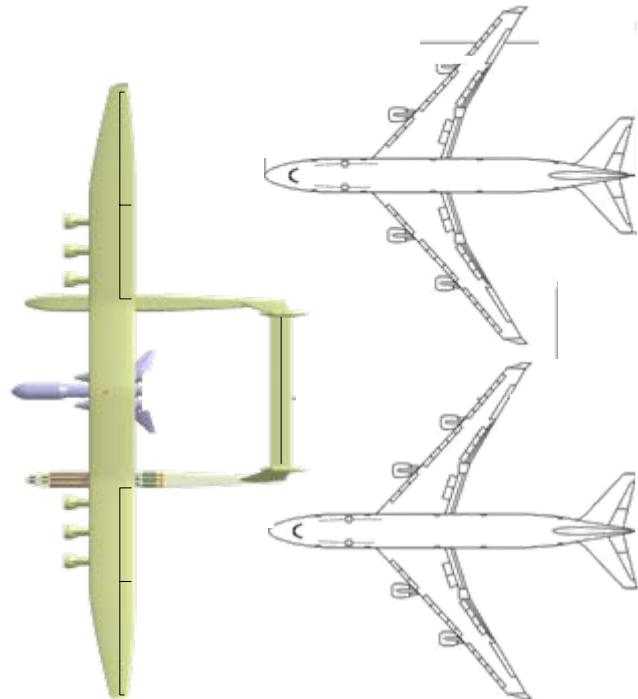


Russian Eksanoplans (wing-ships)



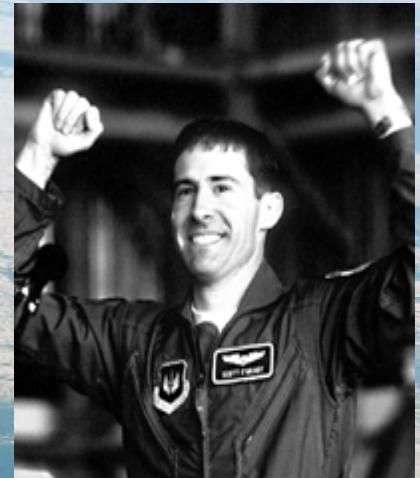
Heavy lift via use of a large space launcher

Payloads up to 450klb



UAV vs. Manned Aircraft Systems

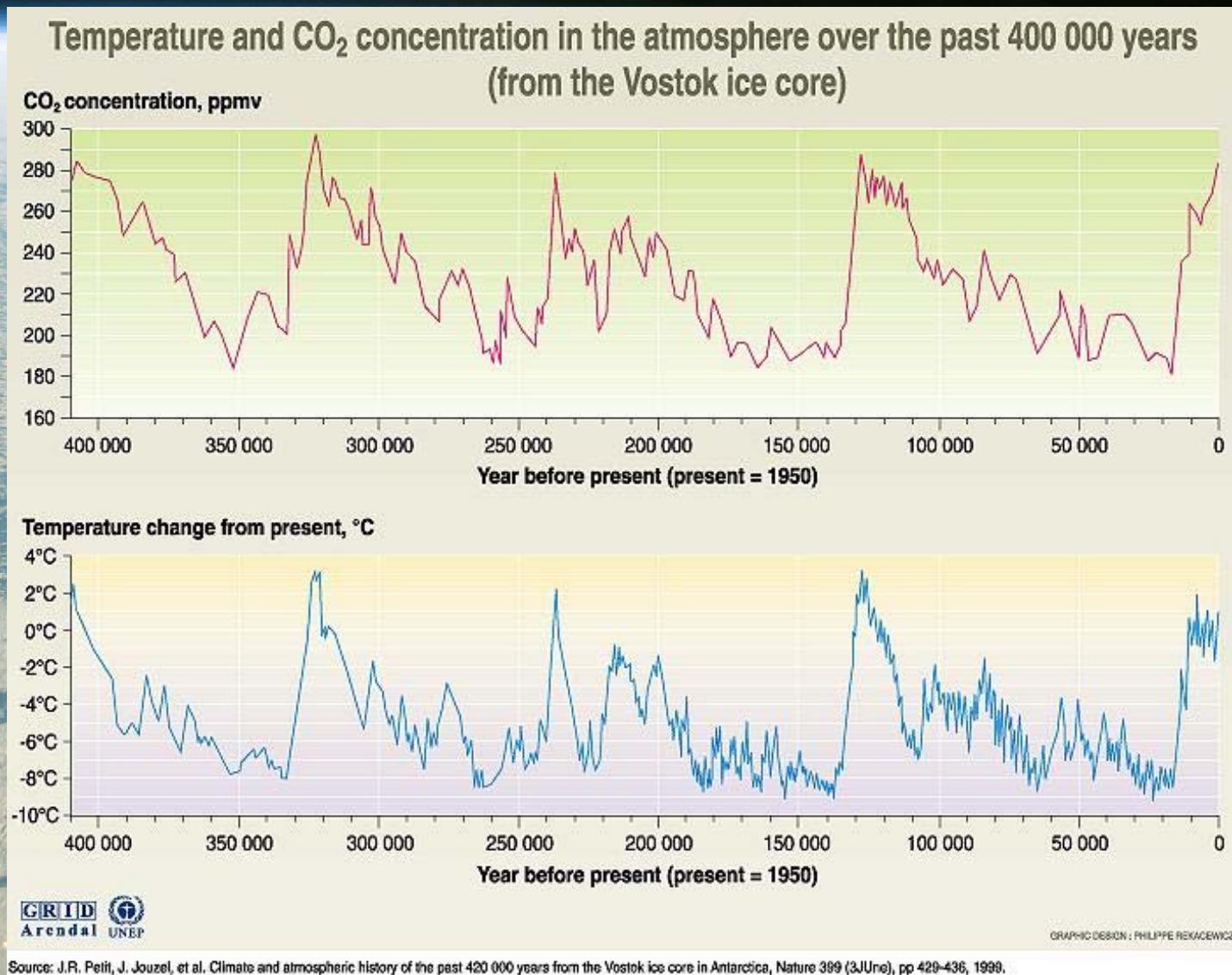
- The fighter pilot's proficiency
 - Our leadership maintained?
 - Proliferation
- The fighter pilot's courage
 - Eliminate Capt Scott O'Grady?
- Cost savings?
 - Development and Ops



Are we destroying the planet?

Consensus vs. Science

Technical solutions follow technical measurement



Humanity's future in a connected world

- Internet....the tip of a huge iceberg
 - Our need to travel, if a virtual mode is available
 - Countries – defined by belief, not by geography
- Humanity – we are just getting started

Pacific Theater Operational Science and Technology Conference

Future Solutions - ISR

April, 2007

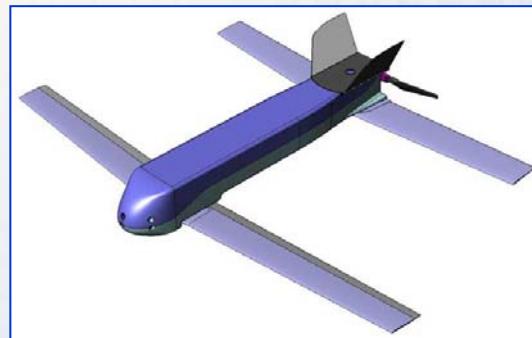


John Grabowsky
Executive VP, GM UAS
AeroVironment, Inc.



Three New Platforms & Supporting Technologies

- Stratospheric ISR
 - Global Observer
- Squad-Level ISR
 - Wasp
- ISR, with teeth
 - Switchblade



AV's Operating Space

Altitude

*24/7/365
Affordable Persistence:
ISR, Comm Relay*

Global Observer



Dragon Eye



Raven



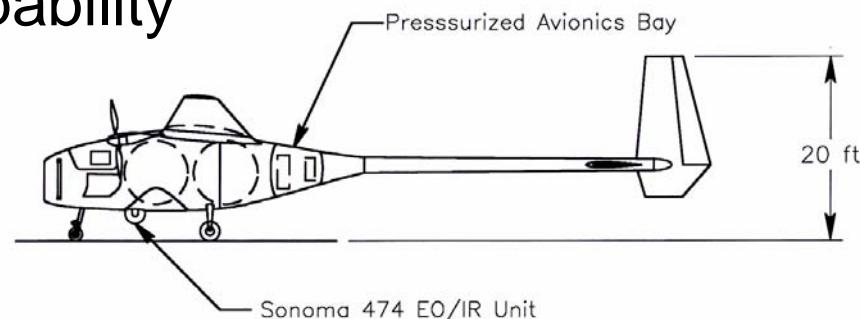
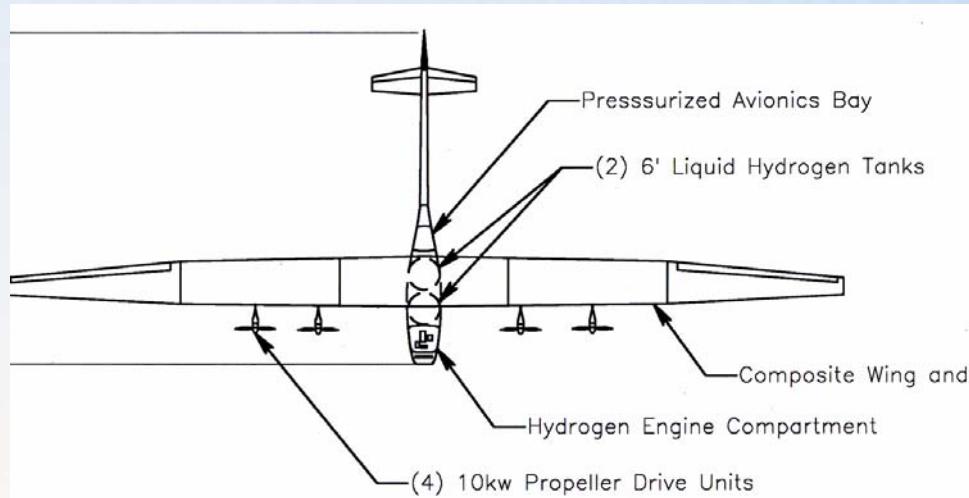
Puma

*Low-cost, easy to field
information gathering
for war fighters*

Endurance

Value of Affordable Stratospheric Persistence

- Quick Reaction
 - In/out theater Bandwidth
 - Comm Relay
 - ISR
 - Psy Ops
 - Disaster Recovery
- Compelling O&M and LCC Benefits
- Ability to “Reconstitute Capability”



20 years of stratospheric flight experience



Pathfinder-Plus



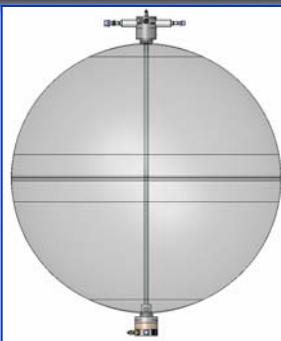
Centurion



Helios

Underlying Technologies

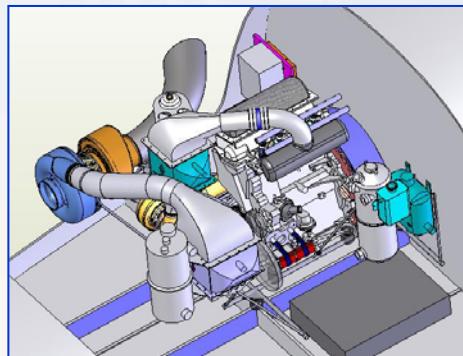
- LH₂ Tank



GO-0 Flights



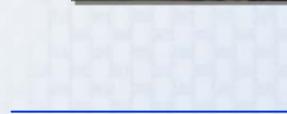
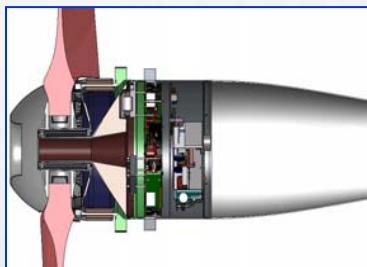
- LH₂ Powerplant



- Efficient Electric Generator



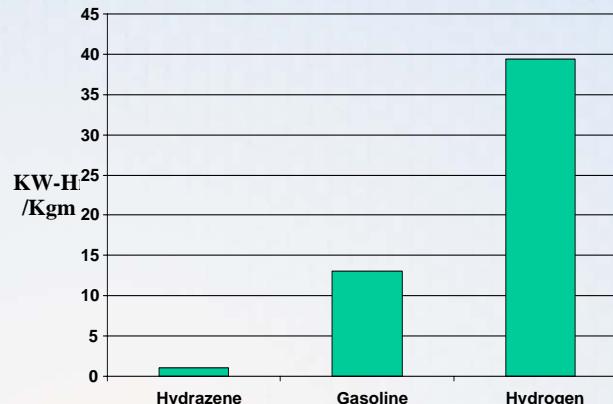
- Efficient Propulsion



Energy Densities and Efficiency

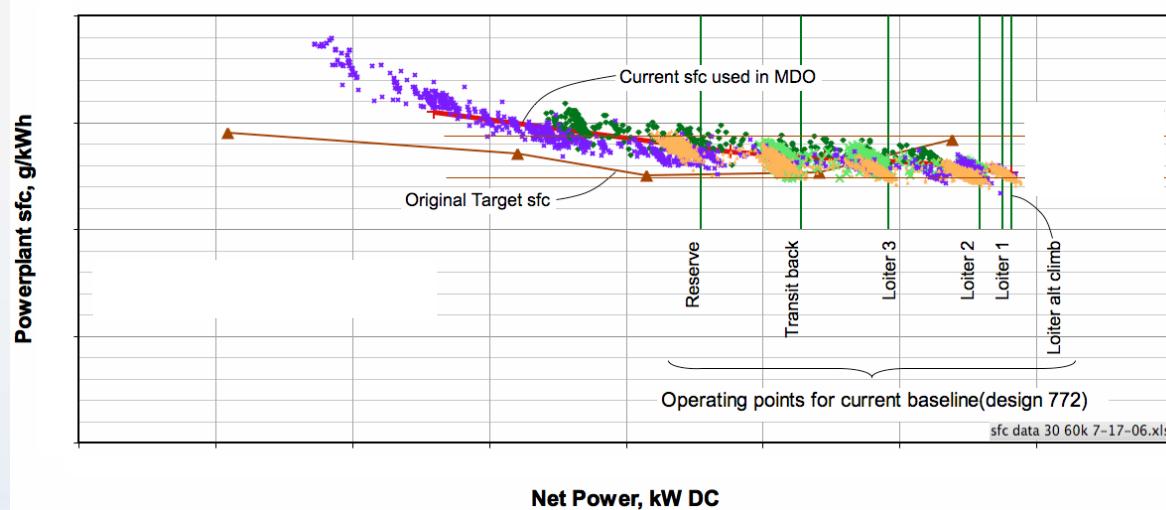
- Why Hydrogen?

Specific Energy of Potential]

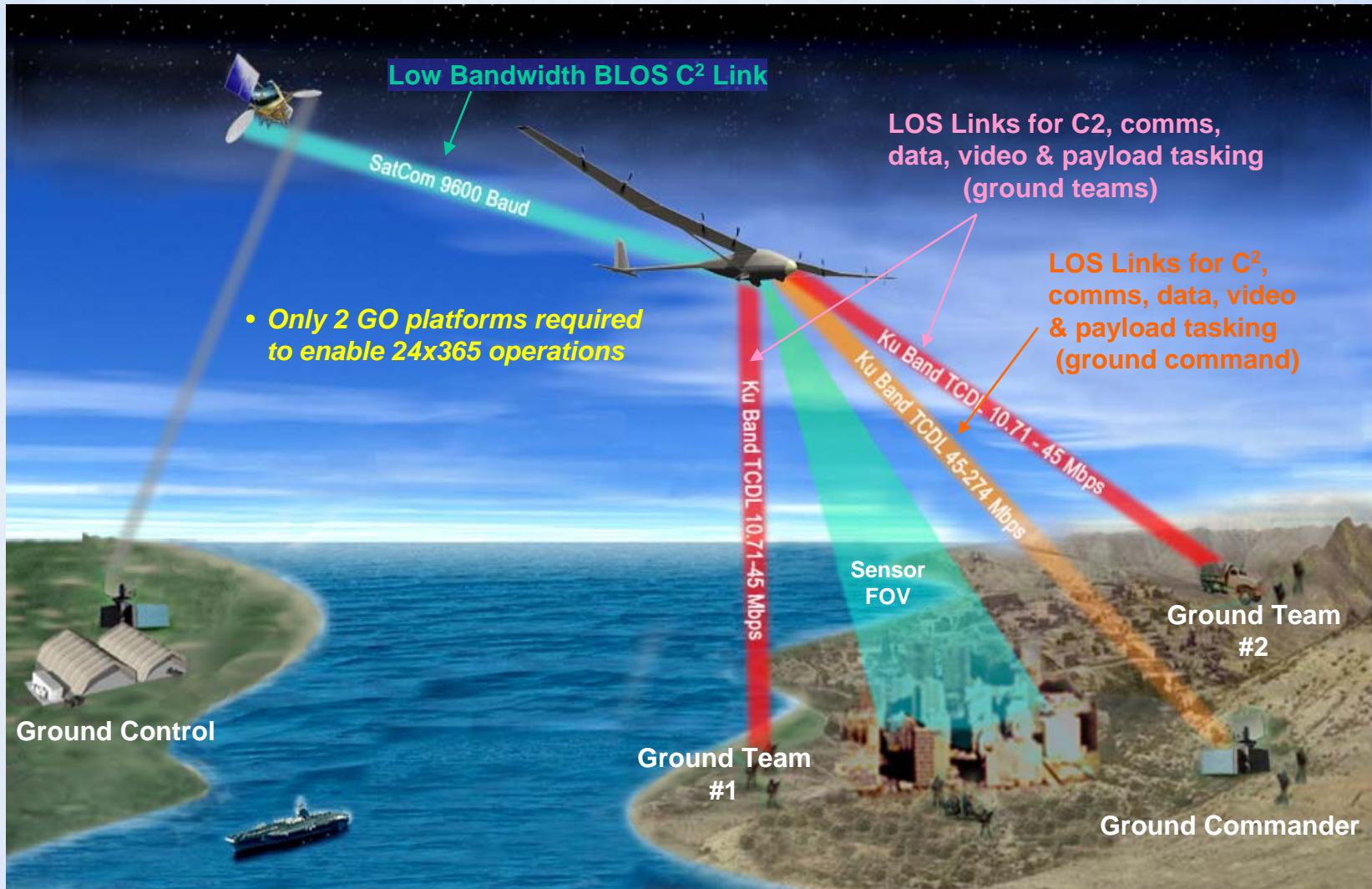


- Specific Fuel Consumption

Efficiency at 65k ft based on net dc output power (after ancillaries)



Military ISR and Relay Mission



Global Reach



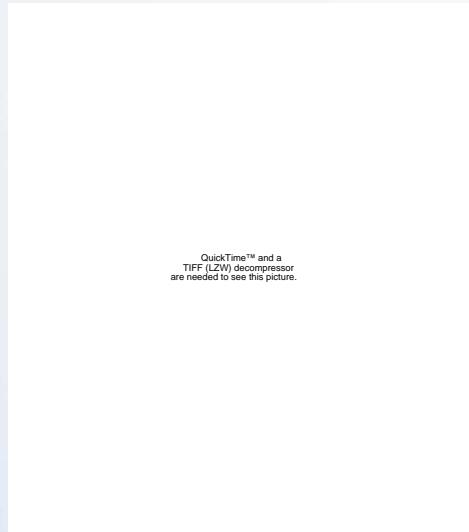
Continuous (24/7/365) persistence over any point in
footprint with 2 aircraft

Squad-level ISR: Wasp



Requirements for Squad ISR

- Small, Lightweight, *System* Rucksack-portable
- Day and Night sensors
- 30+-minute endurance
- Rugged, Reliable
- Low cost
- Low-Observable

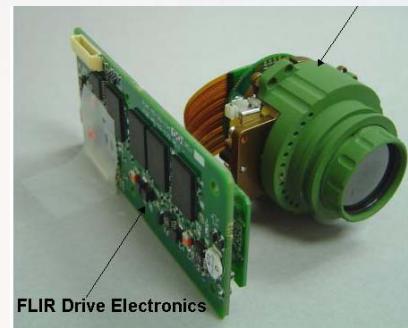


Supporting Technologies: Payloads

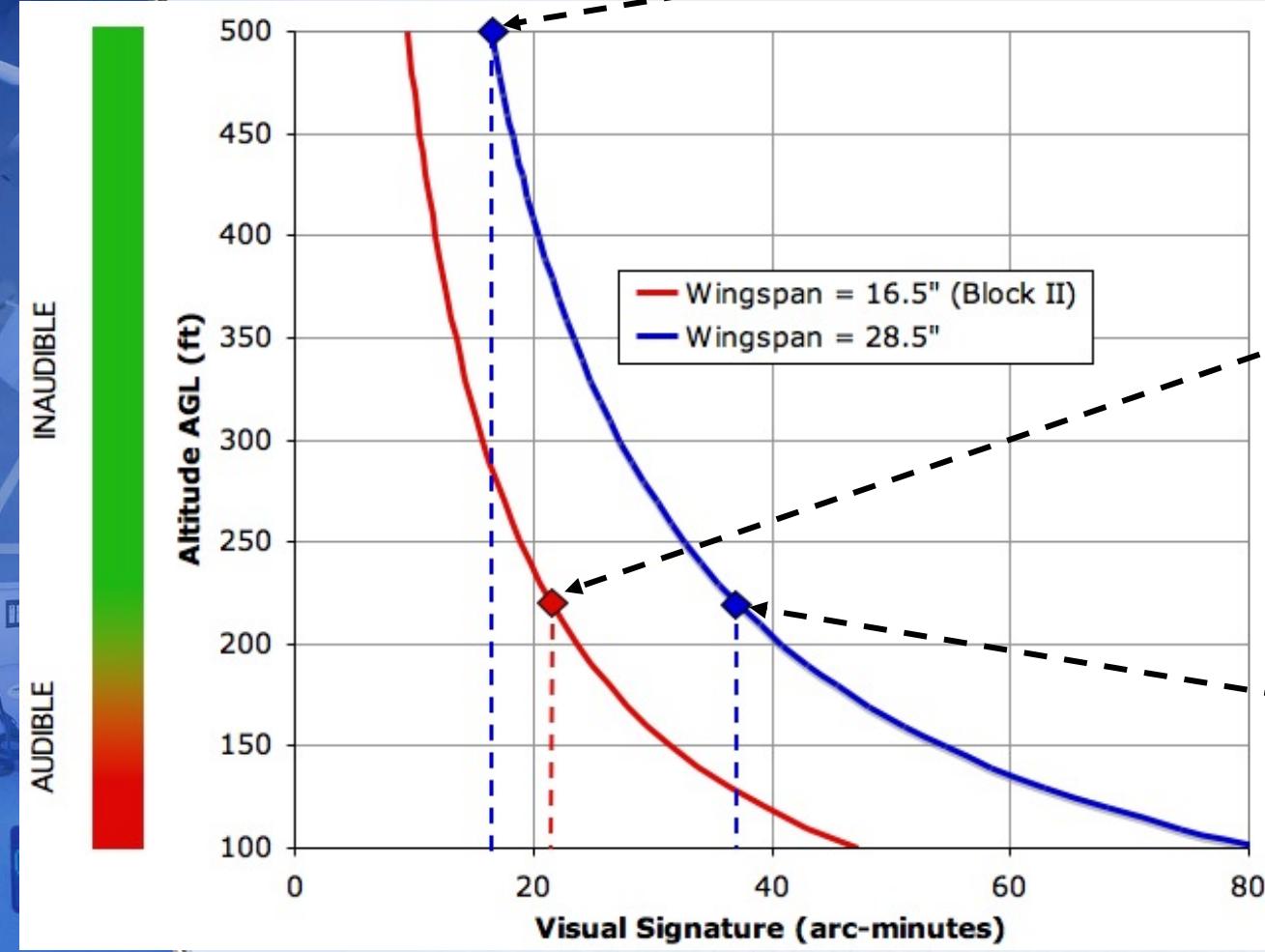
- Electric Propulsion
 - Rugged
 - Quiet
 - Efficient
 - Inexpensive



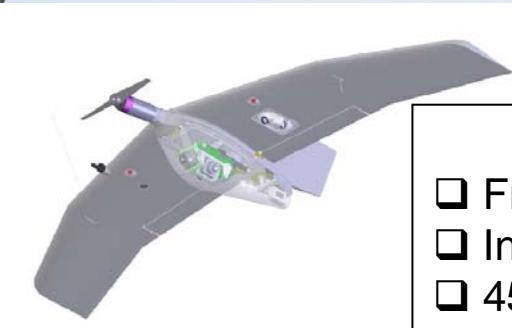
- IR Payload
 - LWIR
- EO Payload
 - Digitally stabilized
 - Steerable



Visual/Acoustic Signatures and Resolution



Wasp Block III Configurations

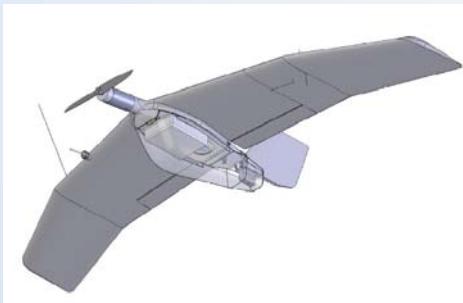
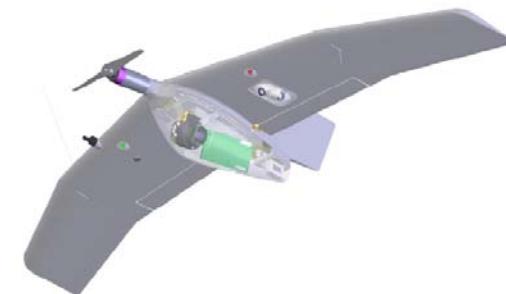


Daytime Wasp

- Front/side imager, digital image stabilization and pan-tilt-zoom
- Integrated dual EO payload
- 45-minute endurance

Nighttime Wasp

- Thermal imager
- Integrated dual EO payload
- 40-minute endurance



Long Endurance Wasp

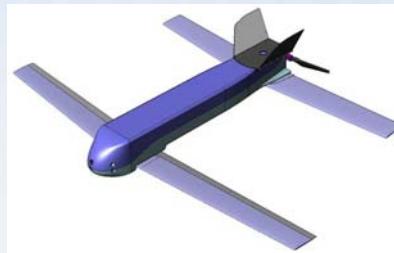
- Extended endurance battery pack (double the capacity)
- Integrated dual EO payload
- 100+ minute endurance calculated

Man-portable ISR, with teeth: Switchblade



Squad-level Lethal UAV Requirements

- Man-Portable SYSTEM
 - Air Vehicle
 - Launcher
 - GCU
- Low Optical/Acoustic Signatures
- High Speed
- Autonomous Terminal Guidance
 - Small CEP
- Warhead
 - Lightweight
 - Lethal
 - Minimal Co-lateral
- Low Cost per round



Air Vehicle

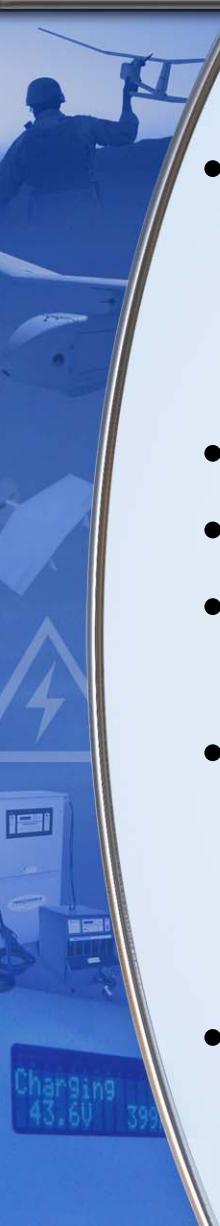


Warhead



Launcher

Raven/Wasp
GCU



Supporting Technologies

- Lightweight Launcher
 - Simple, reliable launch mechanism
 - Low acoustic signature
- Miniaturized Avionics
 - G-hardened
 - GPS, RF Data Link, IMU, Air Data
- Lightweight Propulsion
 - Quiet efficient motor, propeller, Batteries
- Lightweight Lethal Payload
- Autonomous Terminal Guidance
 - Operator Initiated
 - Low CEP Video Tracker

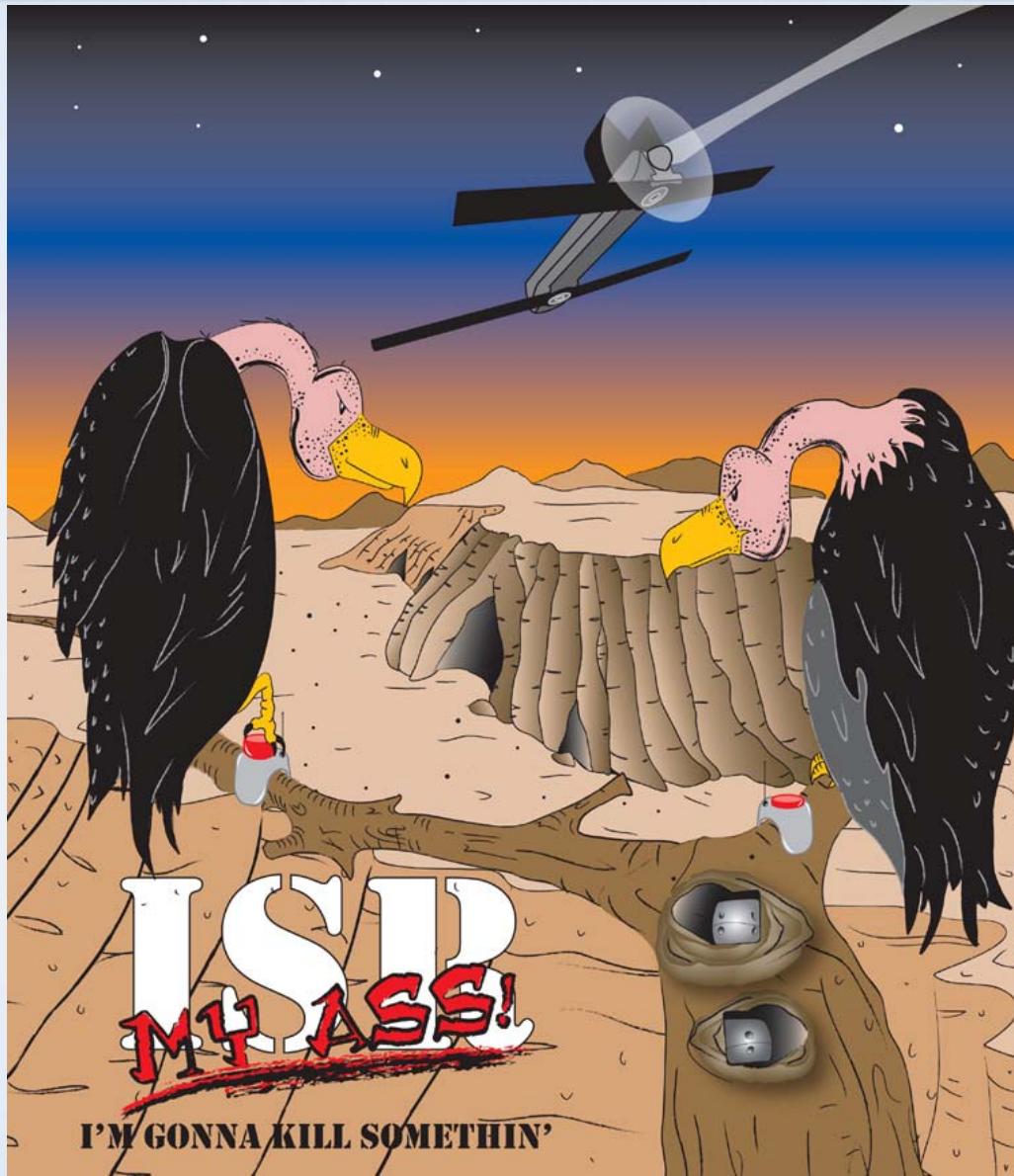


Small CEP Tracker



QuickTime™ and a
Cinepak decompressor
are needed to see this picture.

The End



Aligned with your needs.

Pacific Operational Science and Technology Conference Panel Discussion Undersea Warfare

Mr. Roger Bagbey

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Alion Science and Technology Corporation

4 April 2007



USW Panel Agenda

- NDIA Undersea Warfare Division
- Basis for Industry Meeting PACOM's Needs
 - Knowing What's Needed for USW
 - Opportunity for Return on Investment
- An Example
- Summary



- **The USW Division defines Undersea Warfare as: Anti-Submarine Warfare (ASW), Mine Warfare (MIW), Surveillance, and Special Operations**
- **Organized into five focus areas:**
 - Sensor Systems, Mine Warfare (MIW) Systems, Undersea Vehicles, Aviation, and C4I and Combat Systems
- **Sponsors Two Major Technical Conferences**
 - Joint Undersea Warfare Technology Spring Conference
 - Joint Undersea Warfare Technology Winter Conference
- **Currently Conducting Two Technical Studies for USN Sponsors**
 - ASW Common Tactical Picture Study, 8 June 2006- in process
 - Distributed Netted Sensor Study, 6 January 2006 – in process



Overview of USW Division

- **USW Division Identified Key Technology Areas**
 - Deployment
 - Sensing
 - Communications
 - Distributed Command and Control
- **2007 Spring Joint Undersea Warfare Technology Conference** - About 400 attendees
 - Senior Navy Leadership Provided Classified USW Status and Concerns
 - 126 Program and Systems Briefs Presented In A Classified Forum

Basis for Industry Meeting PACOM's Needs

- **Knowing What's Needed**

- Threat
- Operational Constructs
- Constraints
- Challenges



- **Opportunity for Return on Investment**

- Availability of funding
- Protection of Intellectual property
- Timeliness of Return





Knowing What's Needed for USW Beyond 2010

- **Science & Technology**

- DARPA
- ONR (BAA, SBIR, STTR, FNC, etc.)
- NDIA (Bi-Annual Conferences, Special Studies)
- NRAC, NSB (Special Studies)
- Etc.

- **System Development**

- PEOs/SYSCOMS
 - Performance (System) Specific RFP
 - Formal Acquisition Process
 - Directed BAA
 - e.g. Theater ASW, Periscope Detection Radar

- **Navy Master Plans (ASW, MIW, UUV, ...)**





Aligned with your needs.

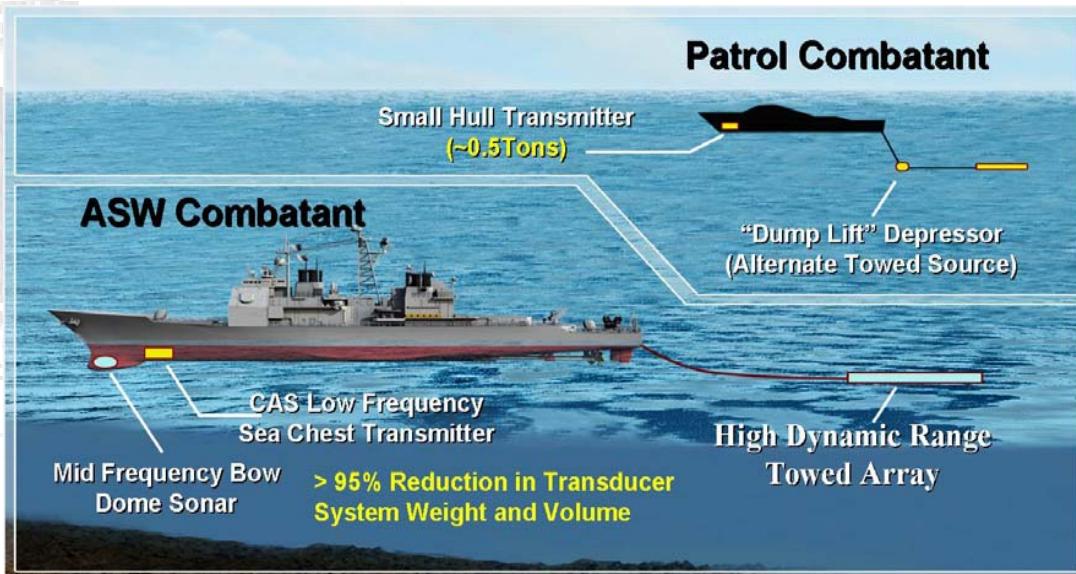
Opportunity for Return on Investment

- Availability of Funding
 - General Decline Known & Accepted
 - PBD 753 Augments ASW R&D
- Protection of Intellectual property-Versus:
 - Peer Reviews
 - Open Sourcing
- Timeliness of Return on Investment
 - Rapid Development Concept
 - versus
 - Business as Usual



Aligned with your needs.

An Example from Alion Experience: Continuous Active Sonar (also Receive While Transmit (RWT))



What is it?

- High Dynamic Range Electronics permits receiver cancellation of directly transmitted signal without disturbing echo reception
- Radar heterodyning technique converts continuous echo to narrowband signal with frequency proportional to range

How does it work?

- More Energy on Target With Less Power (Smaller, Low Impact, Transmitters)
- Increased Time x Bandwidth Product (Lower Detection Thresholds)
- Narrowed Track Gates (Better Range Rate Resolution; Reduced Clutter)
- Enables Many Implementation Concepts (Ship Based; Off-board, & Distributed)

Bottom Line: Longer Detection Ranges/Reduced Latency/Lower Cost



USW Discussion Summary

- NDIA has a functional and focused structure and its members remain anxious to support PACOM's USW Needs
- Funding Limitations are a fact of life that Industry accepts
- Industry's ability to innovate is conditioned by DoD policies, e.g. Security, Peer Review , Open Sourcing , and Acquisition Timeliness

Industry can meet DoD S&T needs and welcomes more direct warfighter interaction

Aligned with your needs.

Questions and Comments

Maritime Domain Awareness – *Future Industry Solutions... FY10 and Beyond*

Tom Williams

4 April 2007

The Challenge

Conventional Warfare



Global War on Terror



Forward Presence

"We Need a NORAD for Maritime Forces"

*Admiral Vern Clark, Former CNO
(August 15, 2002)*

The Problem

- Over 150,000 commercial ships
- 80,000 involved in global trade
- 40,000 ships within 1,000 mi of US coastline

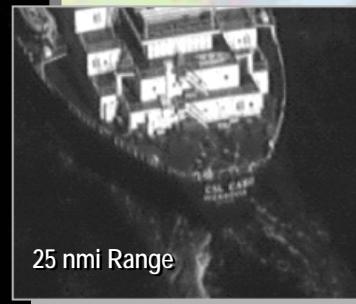
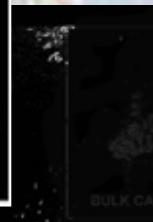


Enabling Technology Investment Areas

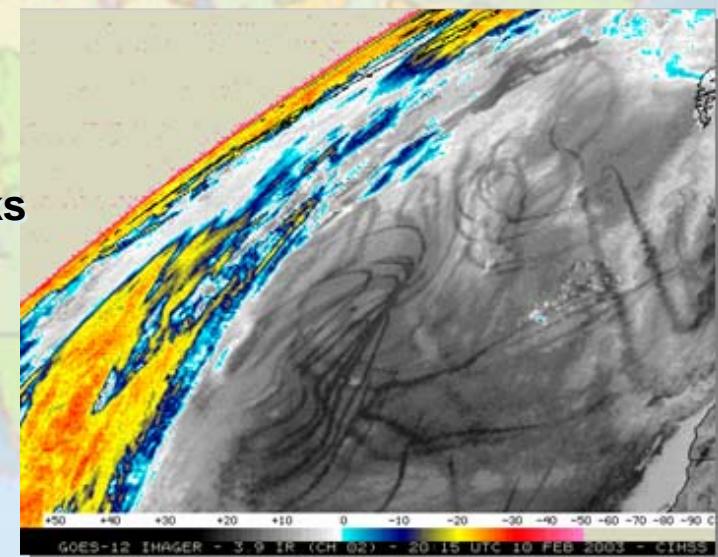
- Ability To Uniquely "Fingerprint" Thousands of Large and Small Hull Commercial Ships
 - Fusion and Reasoning Tools
 - Persistent Surveillance
 - Cooperative Communications / Information Sharing

“Finger Printing”

- AIS (Automatic Identification System)
- EO/IR
- Radar/Radar Emissions
- Acoustics
- Hyperspectral
- Other Unintended Emissions



- Less Uncertainty
- More Targets
- Greater Ranges
- Bearings and Tracks



“Knowing Who’s Who with Certainty”

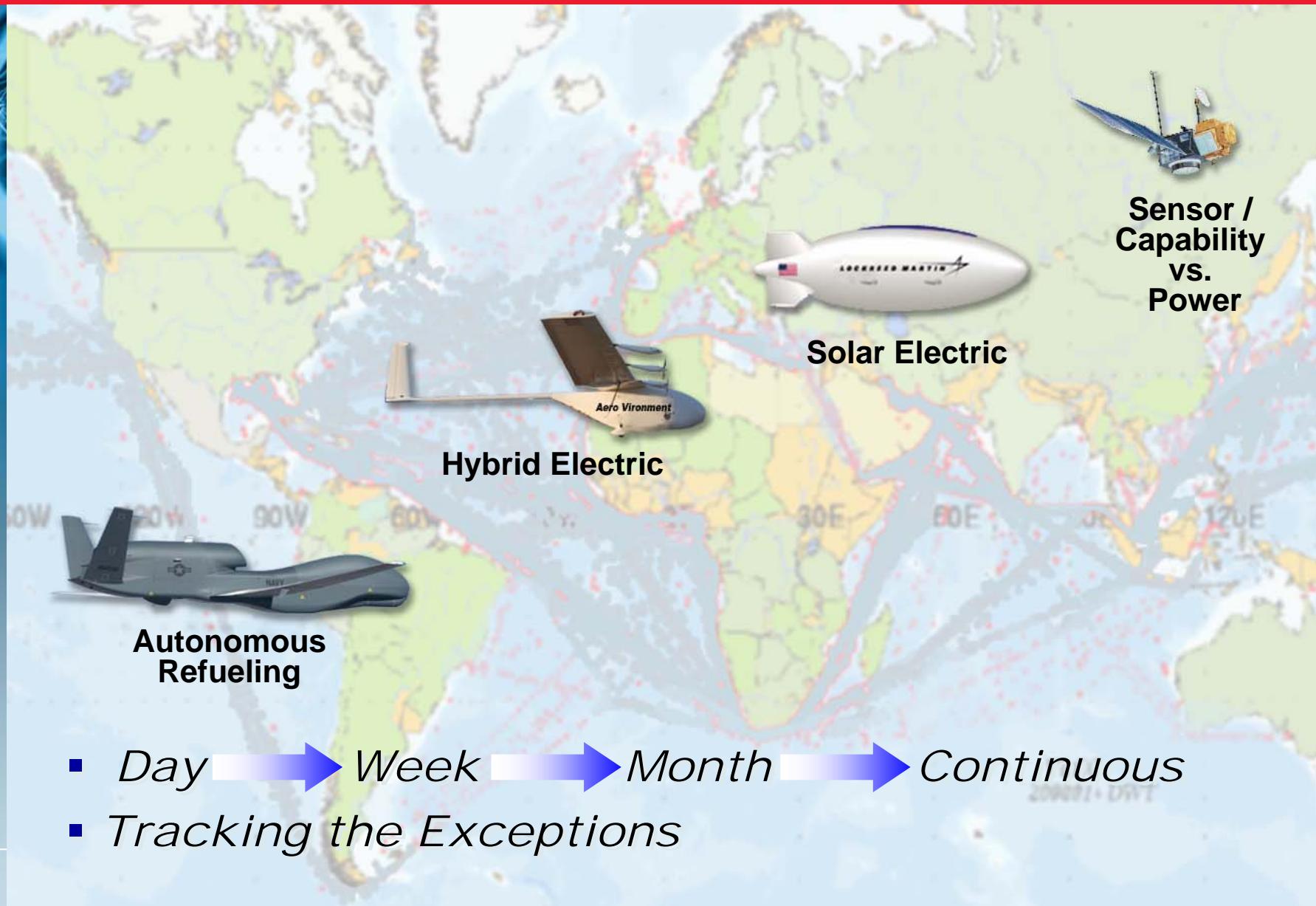
Fusion and Reasoning Tools/Algorithms

- Behavior Analysis / Pattern Recognition
- Netted and Shared Information



- “Clutter Rejection”... Weeding Out the Good Guys
- Knowing Where Your Ship Has Been Lately?

Persistent Surveillance



Cooperative Communications / Information Sharing

- Linking dissimilar systems together cost effectively... Today today
- Assured Comms



- *"Pay for it only when you need it"*
- *Seek options which provide interoperability / netcentricity now, and... enable affordable transition to standards / common systems*

Enabling Technology Investment Areas

- Ability To Uniquely "Fingerprint" Thousands of Large and Small Hull Commercial Ships
 - Fusion and Reasoning Tools
 - Persistent Surveillance
 - Cooperative Communications / Information Sharing

Duck Hunting Made Easy



NORTHROP GRUMMAN

DEFINING THE FUTURE



Intelligence Perspective U.S. Pacific Command

3 Apr 2007

***RADM Andy Singer
USPACOM J2 &
Director, Joint Intelligence
Operations Center***



Integrate Intel, Ops & Plans

- Set conditions for success ... 2/3/5 unified action
 - Includes operational perspective and 'So What' factor
 - Links ops to future planning
- 'Always On' dynamic Intel interaction
 - Increases 2/3/5 situational awareness and info sharing 24/7
 - Shapes ops and plans ... influences decisions
- New Core Value
 - Know theory of victory – challenge with Intel
 - Clarity of data and Intel – not consensus of opinion
 - Quality of analysis
 - Blue – Red team



Intel Mythology

1. Outside world cannot contribute to understanding Intel
2. It is about stealing secrets
 - Higher classification \neq better
3. Is a service + decision maker's master
4. All we need is horizontal integration
 - Vertical first
5. Intel Operators vs. mechanics

So what do we do about it?



“Art and Science” / Domains of Warfare

Socio-Cultural

Epistemologies
Ways of thinking
Deep understanding
Sense-making
Decision-making

Values, Beliefs
Cultures

Mental models
Perceptions

Cognitive

Advanced Analysis
Augmented cognition
Information
Decision support tools
Models / Simulation

ART OF WAR
SCIENCE OF WAR

Information

“...INTs”
Sensors, ISR Systems,
Collecting “objects”
and “events”

Physical

Peace Prevention Deterrence Crisis War Stability Ops/
Transition Peace

DHS Science & Technology: Alignment for Success

Pacific Operational Science &
Technology Conference

Honolulu, Hawaii · April 3, 2007

Jay M. Cohen
Under Secretary
Science and Technology Directorate



Homeland Security





Homeland
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Surprise is nothing new to Hawaii!

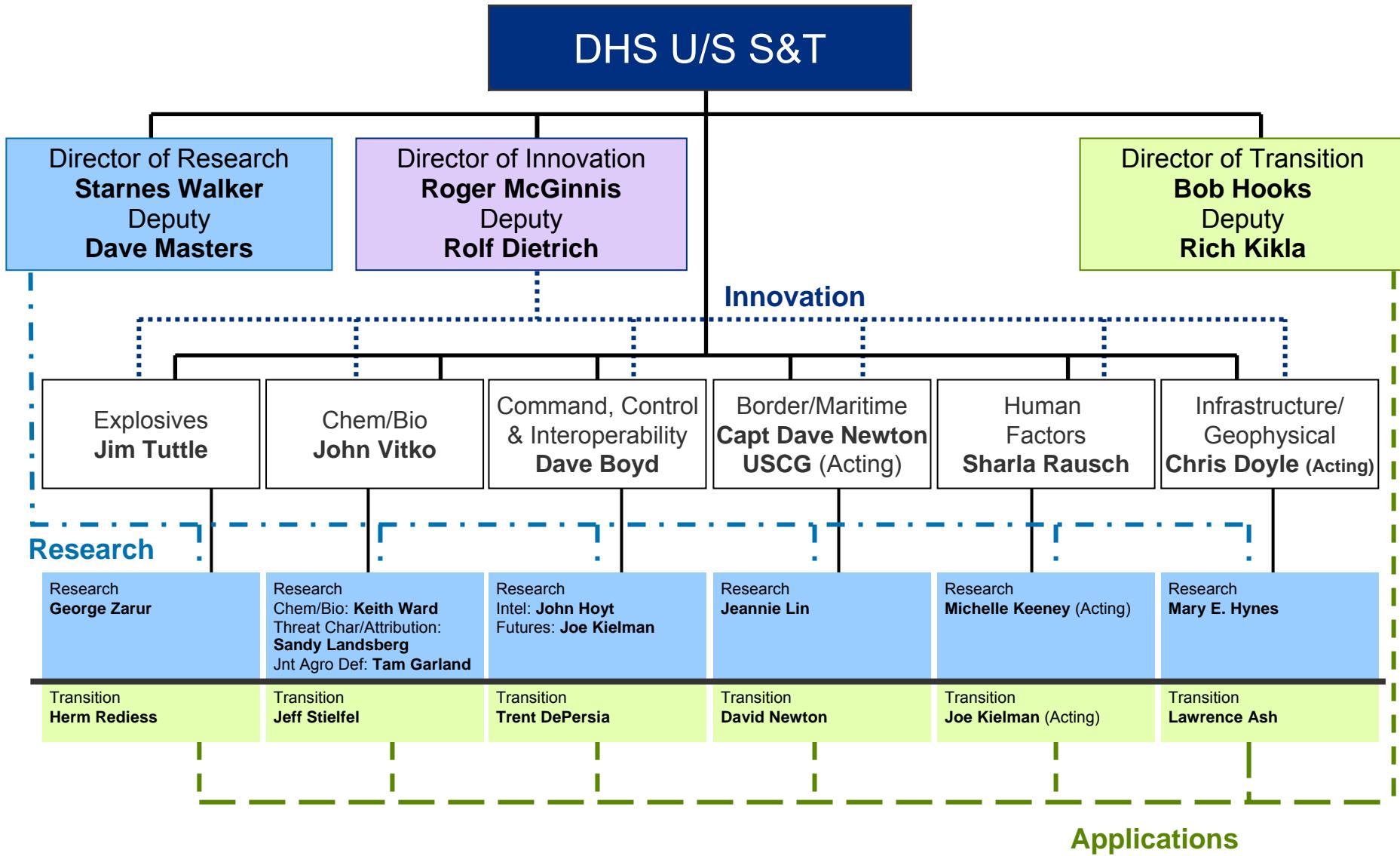
DHS S&T Investment Portfolio

Balance of Risk, Cost, Impact, and Time to Delivery

| | |
|---|---|
| Product Transition (0-3 yrs) <ul style="list-style-type: none">▪ Focused on delivering near-term products/enhancements to acquisition▪ Customer IPT controlled▪ Cost, schedule, capability metrics | Innovative Capabilities (1-5 yrs) <ul style="list-style-type: none">▪ High-risk/High payoff▪ “Game changer/Leap ahead”▪ Prototype, Test and Deploy▪ HSARPA |
| Basic Research (>8 yrs) <ul style="list-style-type: none">▪ Enables future paradigm changes▪ University fundamental research▪ Gov't lab discovery and invention | Other (0-8+ yrs) <ul style="list-style-type: none">▪ Test & Evaluation and Standards▪ Laboratory Operations & Construction▪ Required by Administration (HSPDs)▪ Congressional direction/law |

Customer Focused, Output Oriented

S&T Organization



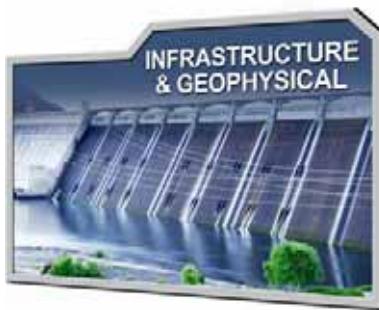
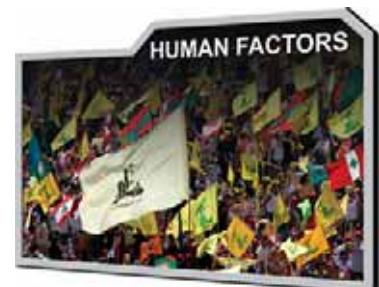
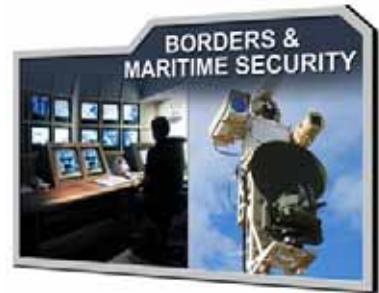
Transition Portfolio

Enabling Capabilities, Supporting Mission Critical Needs of DHS



Integrated Product Teams (IPTs)

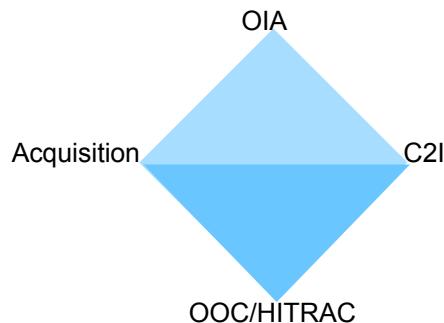
- 11 Capstone IPTs form the centerpiece of S&T's customer-driven approach to product transition
- Engage DHS customers, acquisition partners, S&T technical division heads, and end users in product research, development, transition and acquisition activities
- Identify our customers' needs and enable and transition near-term capabilities for addressing them



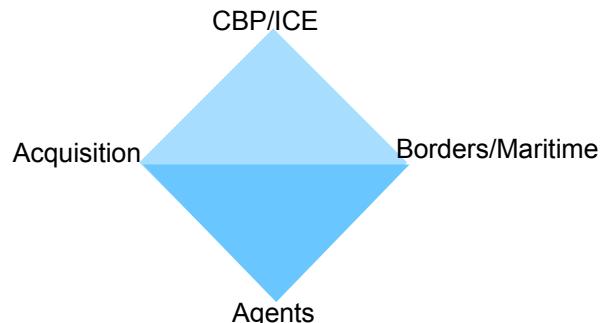
DHS Requirements/Capability Capstone IPTs

DHS S&T Product – “Enabling Homeland Capabilities” (EHCs)

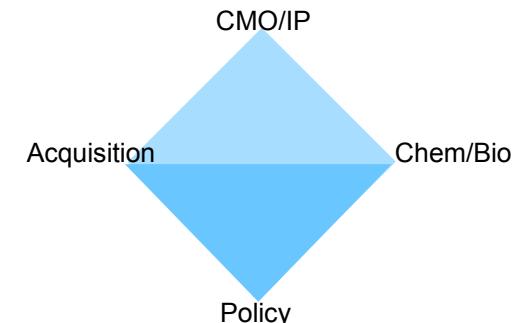
Information Sharing/Mgmt



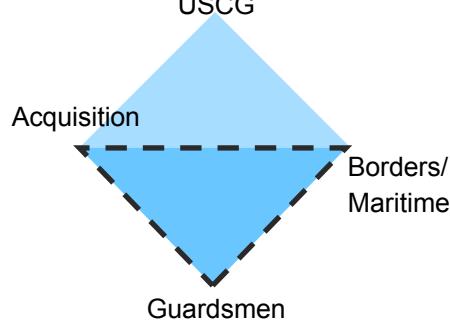
Border Security



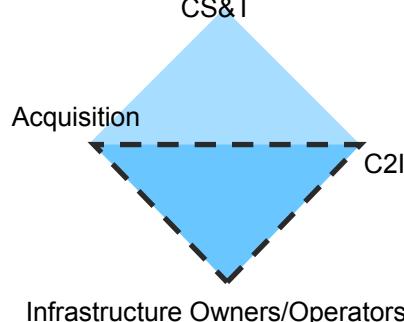
Chem/Bio Defense



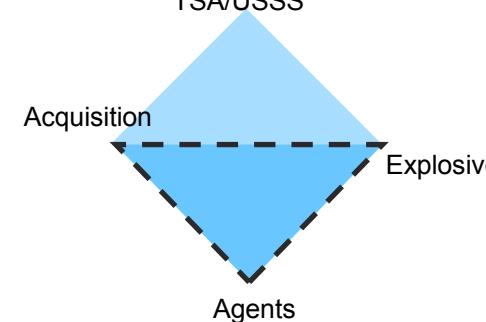
Maritime Security



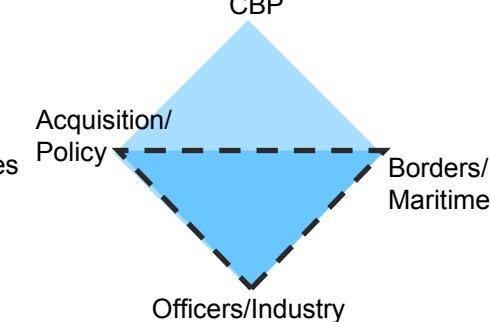
Cyber Security



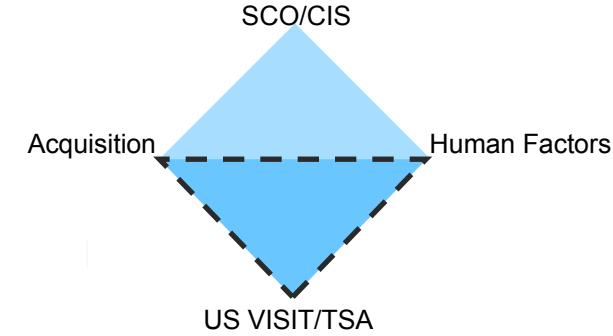
Explosive Prevention



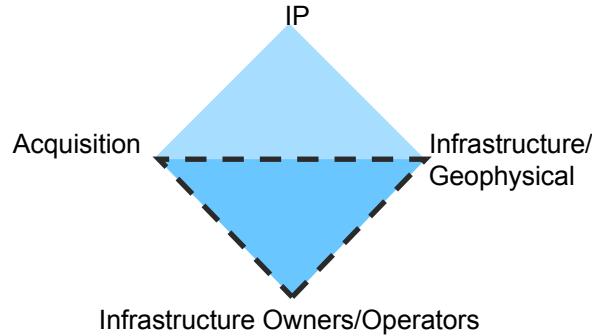
Cargo Security



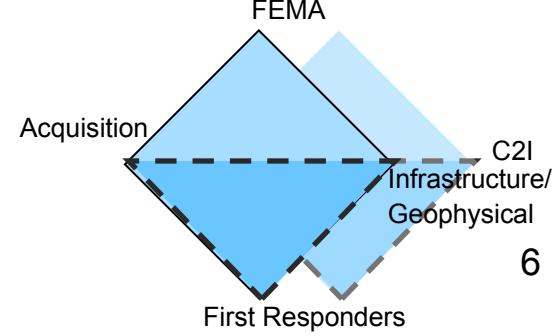
People Screening



Infrastructure Protection



Incident Management

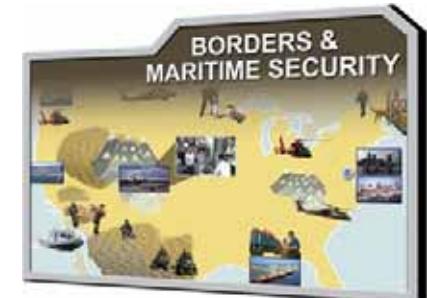
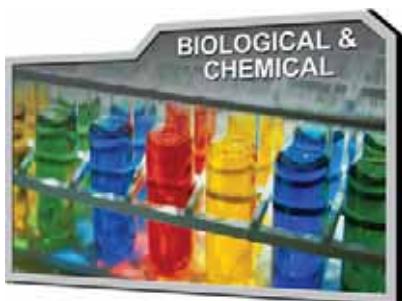


Basic Research Portfolio

Discovery and Invention to Enable Future Capabilities



- Brings the capabilities, talent and resources of the Homeland Security Centers of Excellence, DOE National Laboratories and DHS Labs to bear to address the long-term R&D needs for DHS in sciences of enduring relevance
- This type of focused, protracted research investment has potential to lead to paradigm shifts in the nation's homeland security capabilities



Homeland Security Act of 2002

HSARPA will....

“Support basic and applied homeland Security research to promote *revolutionary* changes in technologies; advance the development, testing and evaluation, and deployment of critical homeland security technologies; and accelerate the prototyping and deployment of technologies that would address homeland security vulnerabilities.”

**EVERY
TRULY
GREAT
ACCOMPLISHMENT
IS AT FIRST
IMPOSSIBLE!**

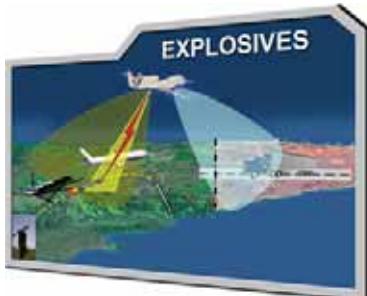
(FORTUNE COOKIE)



**Homeland
Security**

Innovation Portfolio

High Risk, High Gain, Game Changers for Leap-Ahead Results



- Promotes revolutionary changes in technology
- Focus on prototyping and deploying critical technologies
- Includes:
- HSARPA – Homeland Security Advanced Research Projects Agency
- “Homeworks” – 1% of budget highest risk, highest pay-off
- Small Business Innovation Research program
- Visit www.FedBizOpps.gov, www.hsarpabaa.com and www.dhssbir.com



HIPS and HITS

Homeland Innovative Prototypical Solutions (HIPS) are designed to deliver *prototype-level demonstrations* of game-changing technologies in two to five years. Projects are moderate to high risk, with high payoff.

High Impact Technology Solutions (HITS) are designed to provide *proof-of-concept* answers within one to three years that could result in high-payoff technology breakthroughs. While these projects are at considerable risk for failure, they offer the potential for significant gains in capability.



Homeland Innovative Prototypical Solutions (HIPS)

| Explosives | Chem/Bio | Command, Control & Interoperability | Borders/ Maritime | Human Factors | Infrastructure/ Geophysical |
|---|----------|---|--|---|--|
| <p>Project Chloe- High altitude aerial platform existing above civil aviation Counter-MANPADS</p> <p>SENSIT – System to identify numerous liquids in baggage</p> <p>IED Defeat / APE VBIED Defeat – Detection/prevention and mitigation technologies to counter IEDs</p> | | <p>SCOPE (Scalable Common Operational Picture Experiment) – Leverages Global Observer JCTD</p> | <p>Scalable Composite Vessel Prototype (SCVP) – Lightweight, composite material with high speed hull</p> <p>SAFECON – 90 second container screening device</p> | <p>FAST M2 (Future Attribute Screening Technology Mobile Module) – Relocatable Lab capable of testing for behavioral/ physiological cues of “hostile intent”</p> <p>Double or triple wide trailer tested at various sites around the country</p> | <p>Resilient Electric Grid – System that will prevent cascading effects of power surge on electrical grids</p> <p>Levee Strengthening and Rapid Repair - rapidly stop a breach in a levee</p> <p>Storm Surge and Hurricane Mitigation</p> |

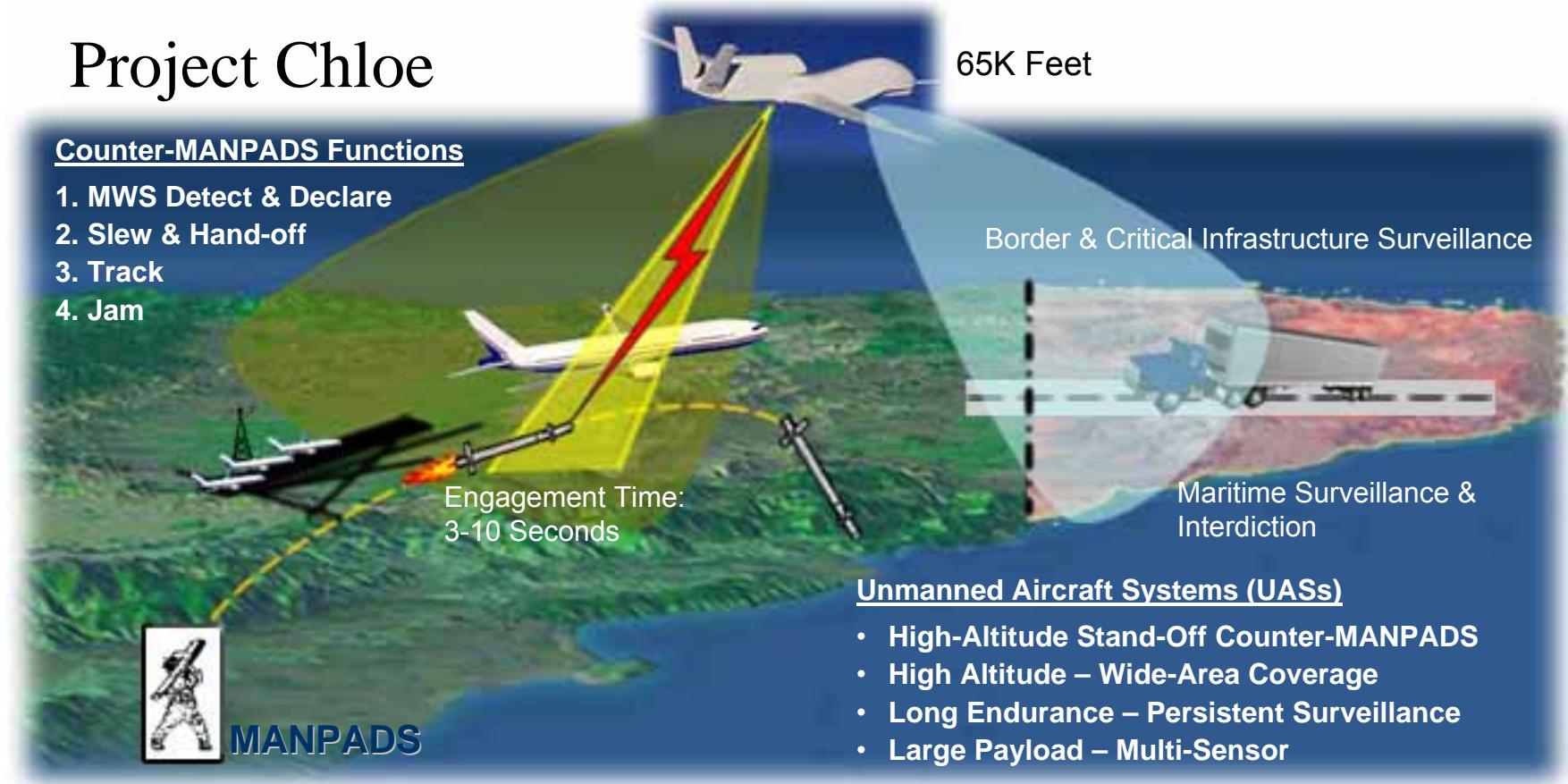
High Impact Technology Solutions (HITS)

| | | | | | |
|--|--|---|---|--|--|
| | <p>Real Time Bio Detection and Identify</p> <p>Cell-All - Ubiquitous Chem/Bio/agent detector</p> | <p>First Net - First Responder Reliable Relay Link</p> <p>Phone Home – Inter-operative and inexpensive hand-held radios</p> | <p>Tunnel Detect – Ability to detect, identify, and confirm illegal and clandestine underground border structures and activities</p> | <p>Document Validator –High proficiency scanner that can identify fraudulent docs</p> <p>Leverage USSS system</p> <p>Biometric Detector – High proficiency small biometric scanner</p> | <p>Wide Area Surveillance/ Change Detection for Critical Infrastructure</p> <p>Resilient Tunnel–Tunnel Protection/Blast Mitigation</p> |
|--|--|---|---|--|--|

Homeland Innovative Prototypical Solutions

Counter-MANPADS/Persistent Surveillance

Project Chloe



Operational Characteristics

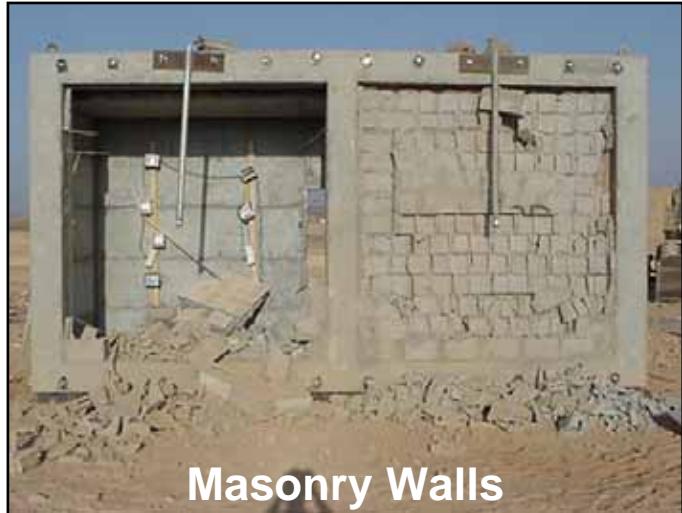
- Real-time sensor fusion/dissemination
- Multi-user / border surveillance requirements
- Commercial Aircraft MANPADS protection
- Automatic target detection/recognition
- Persistence (24/7, all-weather coverage)



**Homeland
Security**

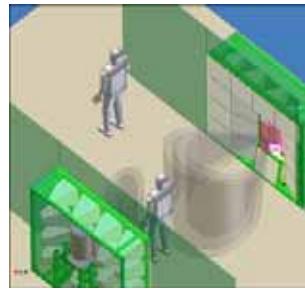
High Innovative Prototype Solutions

Improvised Explosive Devices Defeat



Masonry Walls

Explosive Resistant Coating



- Puffers for explosives trace material detection on people, bags/parcels, and vehicles
- Walk-through/whole-body imaging (e.g., backscatter)
- Advanced Protection Explosive (APE): cancellation methods for explosive shock waves
- Drive-through imaging technology (x-ray, neutron of materials only)

Active Armor



Predict, Detect, Defeat and Destroy

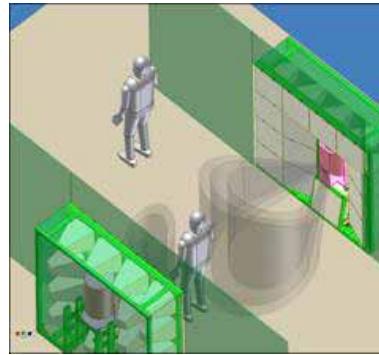
IED/VBIED at range (100 yards) to change the calculus of the bomber versus the defender



Homeland
Security

Homeland Innovative Prototype Solutions

Technologies for Suicide Bomber Defeat & Blast Mitigation



Suicide Bomber & Device Detection



Blast Mitigation



Explosive Device Deactivation



Reactive &
Shaping
Walls

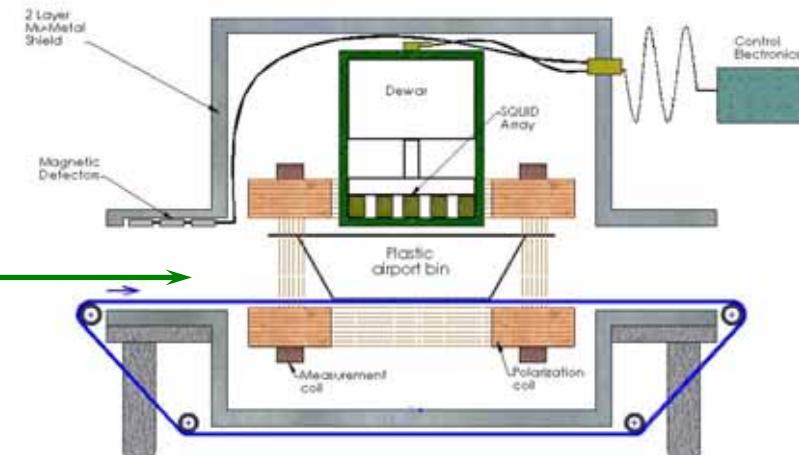


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Homeland Innovative Prototypical Solutions

SENSIT

Liquid & Solid Explosive Detection at Ultra-Low Field *without radiation*



Magnetic Resonance Technology

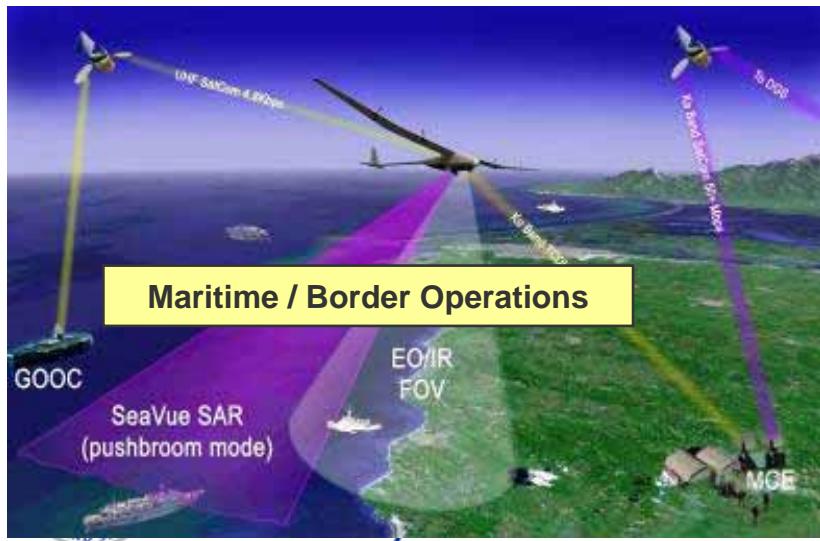
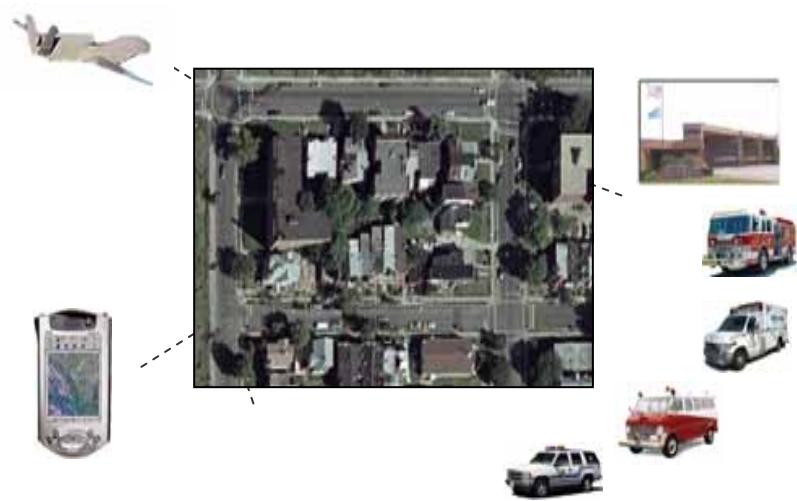
- Detect Liquid & Solid Explosives
- Detect Explosive Components
- Simple “**Green**” / “**Yellow**” / “**Red**” alerts
- Non-contact
- Extremely sensitive
- Materials remain inside baggage
- Applicable at any security portal



Homeland
Security

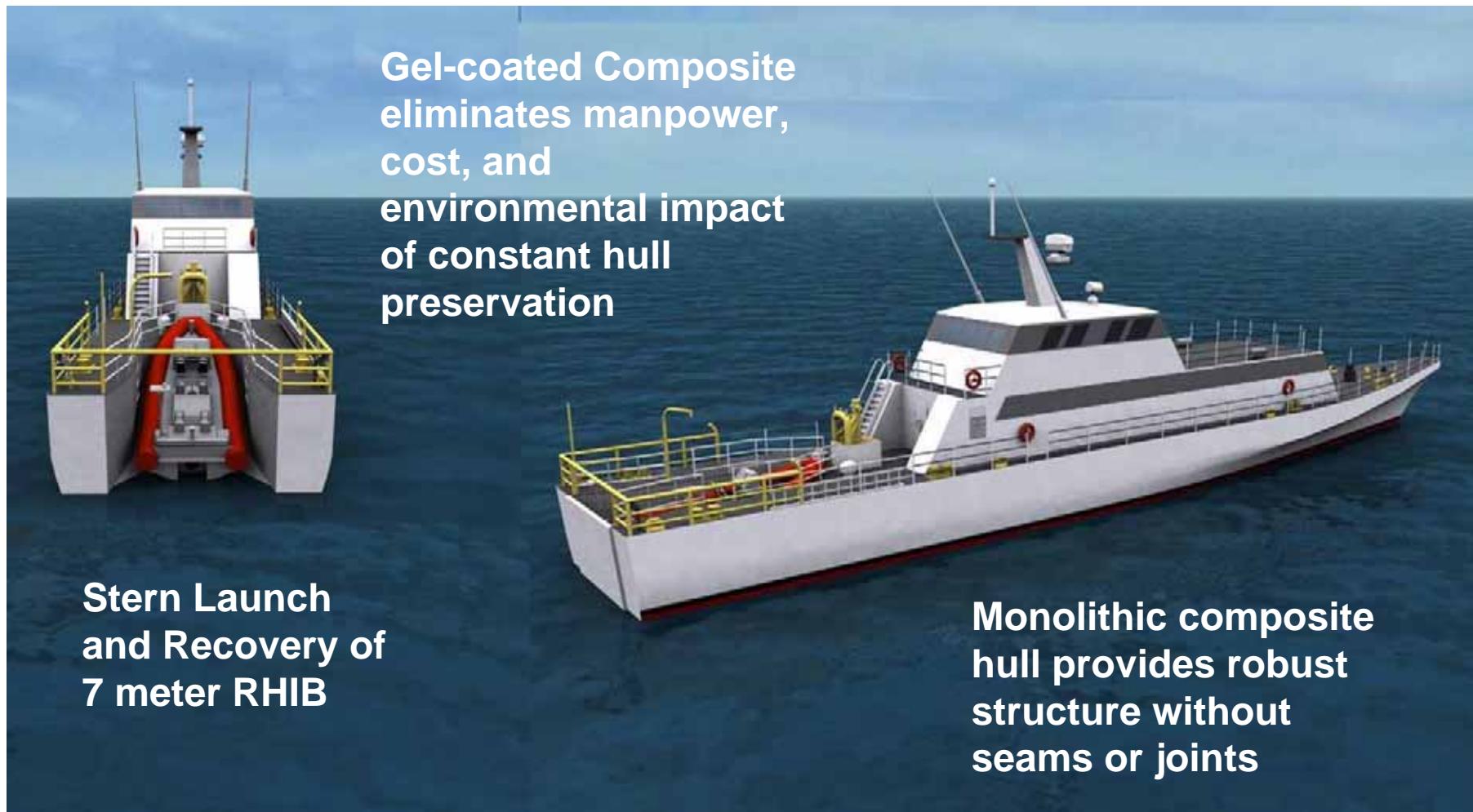
Homeland Innovative Prototypical Solutions

Scalable Common Operating Picture Experiment JCTD



Homeland Innovative Prototypical Solutions

Scalable Composite Vessel Prototype



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Homeland Innovative Prototypical Solutions

SAFECON

Quickly Detect and Identify Dangerous Cargo

Integrated Sensor Suite: explosives, chemical agents, biological agents human cargo, contraband



- Improved Non-Intrusive Inspection (NII) capability
- Improved Sensors for explosives, Chem and Bio agents

Scan for WMD, contraband, and human cargo during normal crane transport operations



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Homeland Innovative Prototype Solutions

Future Attribute Screening Technology Mobile Module (FAST M2)



Systems

- Queue management
- Behavioral profiling
- Rapid risk assessment
- Screening methodologies

Operational Characteristics

- Discover screening methods for intent
- Privacy protection for all participants
- Simple to operate and use

Functions

- Identity verification
- Attribute measurement
- Risk determination
- Behavior focused screening



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Homeland Innovative Prototypical Solutions

Levee Strengthening and Rapid Repair

**Pre-emptive mapping
of weak levees**

**Pre-Flood Deployment of Protective
And Rapid Repair Supplies to
Problem Locations**

**Drop-in structures
lofted by aircraft**



**Float-in structure guided
by cables**



**Explosively Emplaced
Support Structures**

**Roll-out protective
coverings such as
articulated concrete mats**

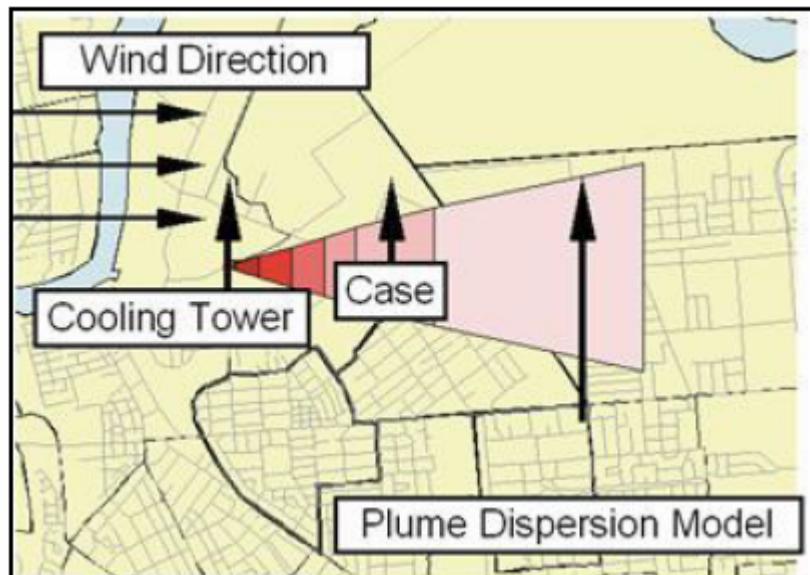


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High Impact Technology Solutions

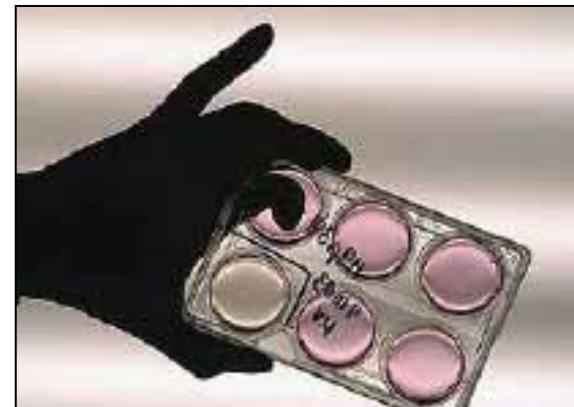
Real Time Bio Detect

Systems to detect biological agents in less than 60 seconds, and then provide RF information transfer to various centers for decision making and corrective action.



VS

Detection via cell culture



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Security**

High Impact Technology Solutions

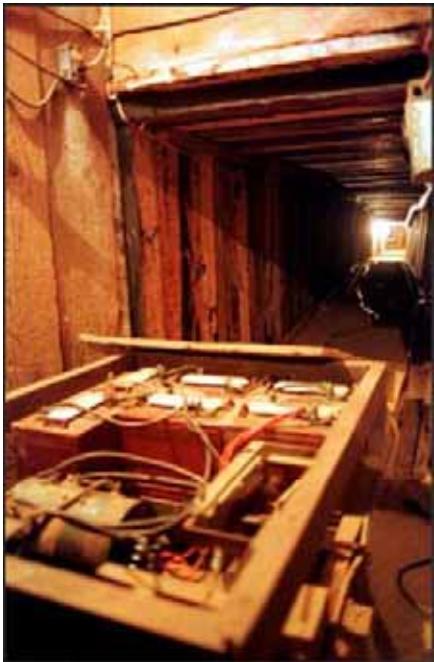
First Net



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High Impact Technology Solutions

Tunnel Detection



- Air circulation
- Electricity
- Concrete infrastructures



**Homeland
Security**

High Impact Technology Solutions

Document Validator

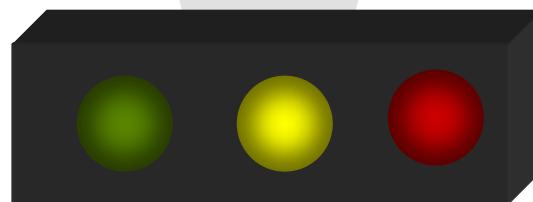


Systems

- Immigration Control
- Queue Management
- Identity databases

Functions

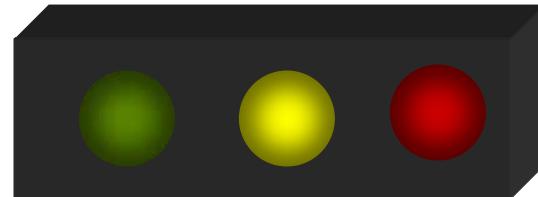
- Document Validation
- Identity verification
- Global identity awareness



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High Impact Technology Solutions

Biometric Detector



Functions

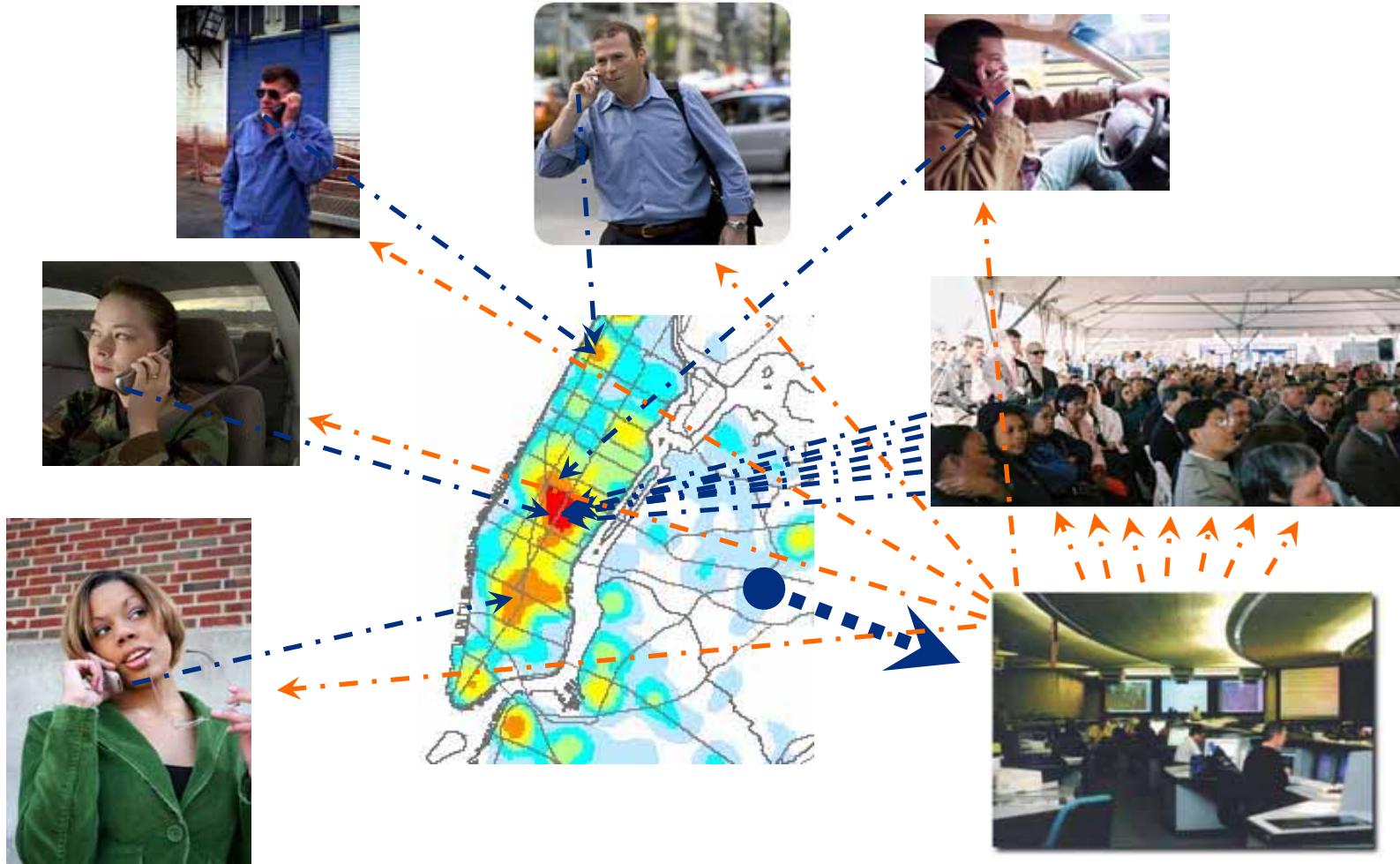
- Identity verification
- Denies right of passage to those on watch lists
- Mobility allows for use in remote locations
- Improved movement of legitimate individuals through checkpoints



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High Impact Technology Solutions

Cell-All Ubiquitous Chem/Bio Detect



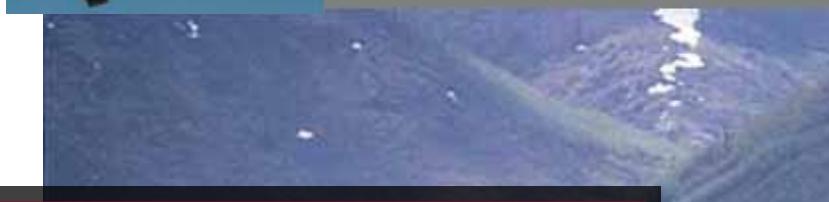
**Homeland
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High Impact Technology Solutions

Critical Infrastructure Change Detection



Explore Methods to
Monitor Critical
Infrastructure



Large and Remote
Locations



Densely Populated
Urban Environments

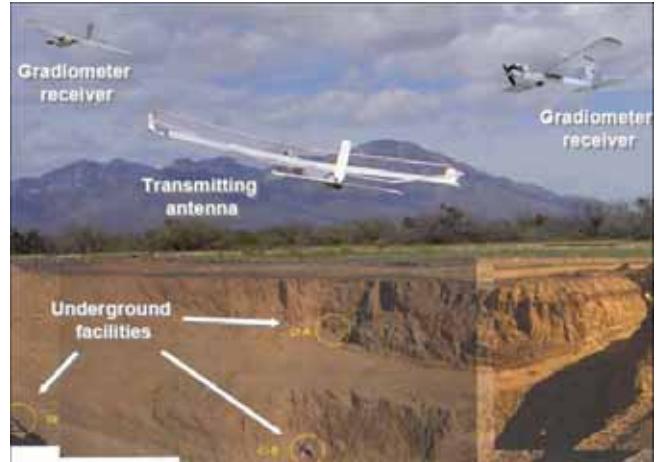


Homeland
Security

Innovation/HSARPA BAAs

Broad Agency Announcements Released
February 1:

- Tunnel Detection Technologies - develop and demonstrate a capability for rapidly detecting tunnels
- SAFE Container (SAFECON) – develop the capability to detect and identify WMD, explosives and contraband cargo and to detect humans in shipping containers
- Future Attribute Screening Technology (FAST) Demonstration Laboratory – provide efficient, rapid and accurate security screening of people and their credentials and belongings



Visit www.FedBizOpps.gov or
www.hsarpabaa.com for more information

Upcoming BAA Topic Areas

- Long-Range - Varied S&T Topic Areas
- CHLOE - High Altitude Endurance Unmanned Aerial System-Based Counter-MANPADS Technology Assessment
- IED & Vehicle-Borne IED Defeat - Technologies for Blast Mitigation and Suicide Bomber Defeat
- SBIR - Small Business Innovation Research Program
- First NET - First Responder Reliable Link
- Document Validator
- Biometric Detector
- SCOPE: Scalable Common Operating Environment

**Visit www.FedBizOpps.gov or
www.hsarpabaa.com for more information**

DoD-DHS Technology Transfer



- Identify and transfer technology from DoD to homeland security applications for emergency responders
- Create a coordinated, sustainable, iterative and inclusive process for tech transfer
- Leverage innovation and investments
- Promote agency and first responder awareness of process



Homeland
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S&T Directorate's A/P Liaison

- Gary Jensen, Director, Asia-Pacific Liaison
- DHS Science & Technology Directorate
- 26 years experience in the Pacific Region
- Established first Mid-Pacific Office for Naval Research
- Coordinated Pacific Region International Field Offices for ONR
- Contact:
 - gary.jensen@dhs.gov
 - Phone: 808-474-1240



Homeland
Security

S&T Activities in PACASIA

- **Government to Government Agreements**
 - An existing umbrella S&T agreement with the Government of Australia,
 - An umbrella S&T agreement in progress with the Government of Singapore
 - Ongoing collaborations with both industry and government in Japan to test cargo container tracking devices under real-world operational conditions.
 - Plans to expand this cargo security initiative to Singapore as soon as our S&T agreement is in place.



Homeland
Security

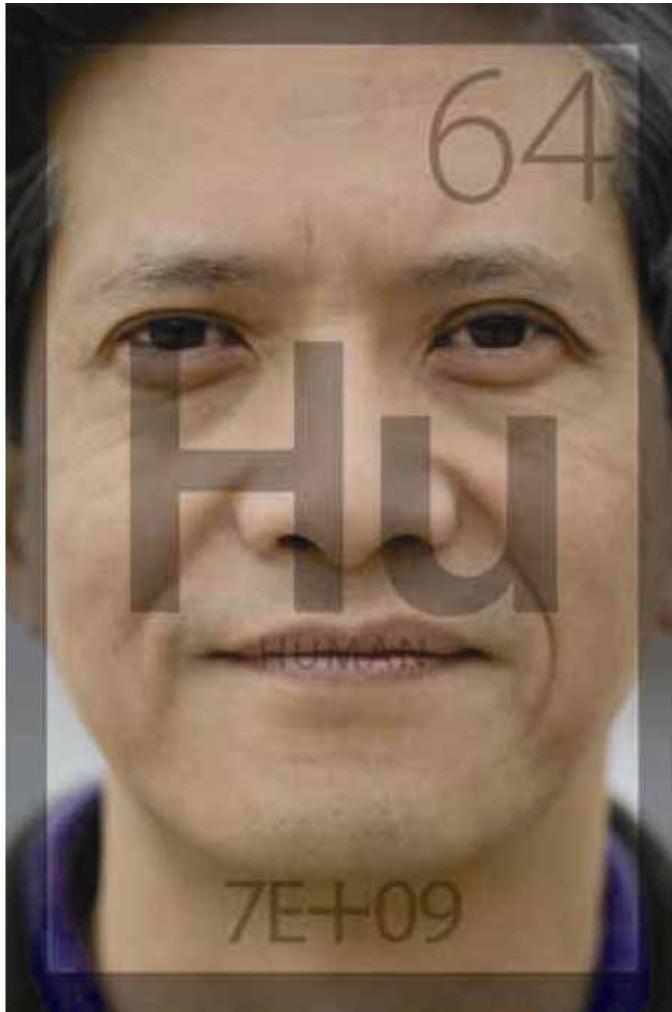
S&T Focus in PACASIA

- Needs of our customers
- - Chemical and biological countermeasures and forensics;
 - Behavioral and physiological tools for people screening; and
 - Cargo tracking and inspection systems.
- Capitalize on the environment and challenges for innovative and leap-ahead capabilities in support of DHS missions and to save American lives. These include
 - Investigating emergency responder tools used by the Japanese government in response to earthquakes
 - Developing satellite-based tsunami forecasting capabilities with our partners in Naval Research
 - Developing hurricane intensity prediction approaches in partnership with the Office of Naval Research and the Mexican Navy
 - Maritime domain awareness and port security tools in partnership with Naval Research, TSWG, and allies such as Singapore.



Homeland
Security

It's ALL about the '*Human Element*!'



Dow's
“Human Element” Ad



Homeland
Security



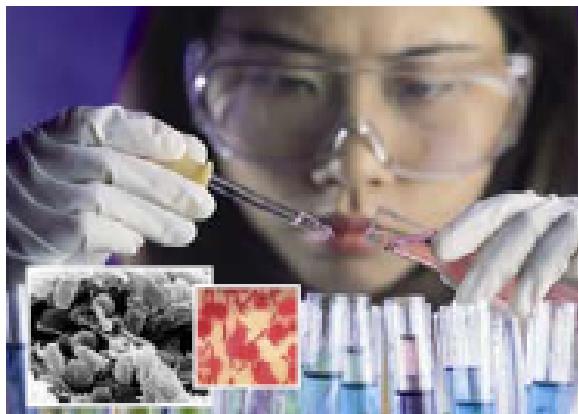
Homeland
Security

FROM SCIENCE...SECURITY

Explosives



Chemical/Biological



Command, Control, & Interoperability



Borders/Maritime



Human Factors



Infrastructure/Geophysical



FROM TECHNOLOGY...TRUST

Back-Up

S&T Points of Contact

| Division | Email |
|----------------|---------------------------------------|
| Jim Tuttle | S&T-Explosives@dhs.gov |
| John Vitko | S&T-ChemBio@dhs.gov |
| David Boyd | S&T-C2I@dhs.gov |
| Dave Newton | S&T-BordersMaritime@dhs.gov |
| Sharla Rausch | S&T-HumanFactors@dhs.gov |
| Chris Doyle | S&T-InfrastructureGeophysical@dhs.gov |
| Bob Hooks | S&T-Transition@dhs.gov |
| Starnes Walker | S&T-Research@dhs.gov |
| Roger McGinnis | S&T-Innovation@dhs.gov |
| Lil Ramirez | S&T-InternationalPrograms@dhs.gov |

Border Security: Representative Technology Needs

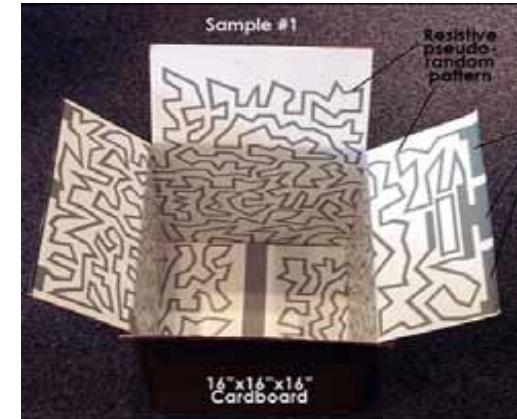
- Improved ballistic protection via personal protective equipment
(Borders/Maritime Division Lead)
- Improve detection, tracking, and identification of all threats along the terrestrial and maritime border
(Borders/Maritime Division Lead)
- Ability to access ICE databases in which voice information is entered; provide analytical, reporting, and automated case deconfliction; classify, identify voice samples *(C2I Division)*
- Non-lethal compliance measures for vehicles, vessels, or aircraft allowing for safe interdiction by law enforcement personnel *(Borders/Maritime Division Lead)*
- Non-destructive tools that allow for the inspection of hidden or closed compartments to find contraband or security threats *(Borders/Maritime Division Lead)*
- Improved analysis and decision-making tools that will ensure the development/implementation of border security initiatives *(Borders/Maritime Division Lead)*
- Ability to non-intrusively determine the intent of subjects during questioning
(Human Factors Division)
- Ability for law enforcement personnel to quickly identify the origin of gunfire and classify the type of weapon fired *(Borders/Maritime Division Lead)*
- Ability for law enforcement officers to assure compliance of lawful orders using non-lethal means
(Borders/Maritime Division Lead)



**Homeland
Security**

Cargo Security: Representative Technology Needs

- Enhanced screening and examination by non-intrusive inspection (*Borders/Maritime Division*)
- Increased information fusion, anomaly detection, Automatic Target Recognition capability (*Borders/Maritime Division*)
- Detect and identify WMD materials and contraband (*Borders/Maritime Division*)
- Capability to screen 100% of air cargo (*Borders/Maritime Division*)
- Test the feasibility of seal security; Detection of intrusion (*Borders/Maritime Division*)
- Track domestic high-threat cargo (*Borders/Maritime Division*)
- Harden air cargo conveyances and containers (*Borders/Maritime Division*)
- Positive ID of cargo & detection of intrusion or unauthorized access (*Borders/Maritime Division*)



**Homeland
Security**

Explosives Prevention: Representative Technology Needs

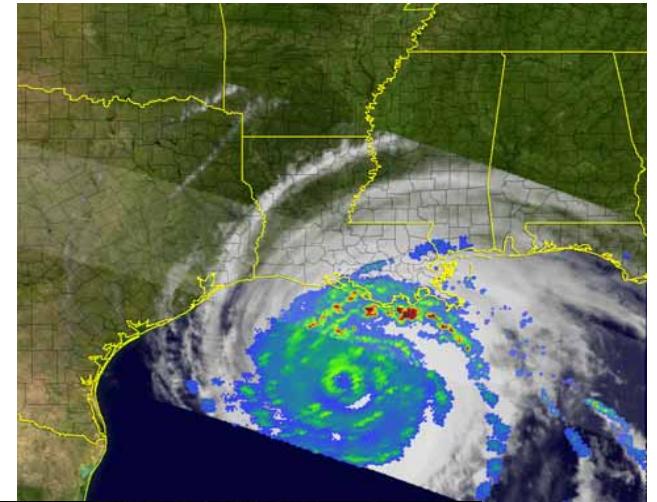
- Standoff detection on persons (portable solutions) (*Explosives Division*)
- System solution for detection in baggage (checked & carried) (*Explosives Division*)
- Capability to detect VBIED / large threat mass (container, trailer, ship, vessel, car, rail) (*Explosives Division*)
- Capability to detect homemade or novel explosives (*Explosives Division*)
- Capability to assess, render safe, and neutralize explosive threats (*Explosives Division*)
- Optimize canine explosive detection capability (*Explosives Division*)



**Homeland
Security**

Incident Management: Representative Technology Needs

- Integrated Modeling, Mapping and Simulation capability (*IP/Geophysical Division*)
- Personnel Monitoring (Emergency Responder Locator System) capability (*IP/Geophysical Division*)
- Personnel Monitoring (Physiological Monitoring of Firefighters) capability (*IP/Geophysical Division*)
- Incident Management Enterprise System (*IP/Geophysical Division*)
- Logistics management tool (*IP/Geophysical Division*)



**Homeland
Security**

Interoperability: Representative Technology Needs



- Development and evaluation of Internet Protocol (IP) enabled backbones (*C2I Division*)
- Test and evaluation of emergent wireless broadband data systems (*C2I Division*)
- Acceleration of development and testing of P25 IP-based interfaces (*C2I Division*)
- Identification and development of message interface standards (*C2I Division*)
- Transition of Land Mobile Radios communication architectures to cellular based architectures (*C2I Division*)
- Evaluation of access technologies (*C2I Division*)
- Development of the complementary test procedures (*C2I Division*)



**Homeland
Security**

Maritime Security: Representative Technology Needs

- Wide-area surveillance from the coast to beyond the horizon; port and inland waterways region - detect, ID, and track
(Borders/Maritime Division Lead)
- Data fusion and automated tools for command center operations *(Borders/Maritime Division Lead)*
- Vessel compliance through non-lethal compliance methods *(Borders/Maritime Division Lead)*
- Enhanced capability to continuously track contraband on ships or containers
(Borders/Maritime Division)
- Improved ballistic personal protective equipment for officer safety
(Borders/Maritime Division Lead)
- Improved WMD detection equipment for officer safety; improved screening capability for WMD for maritime security checkpoints *(Borders/Maritime Division Lead)*



**Homeland
Security**

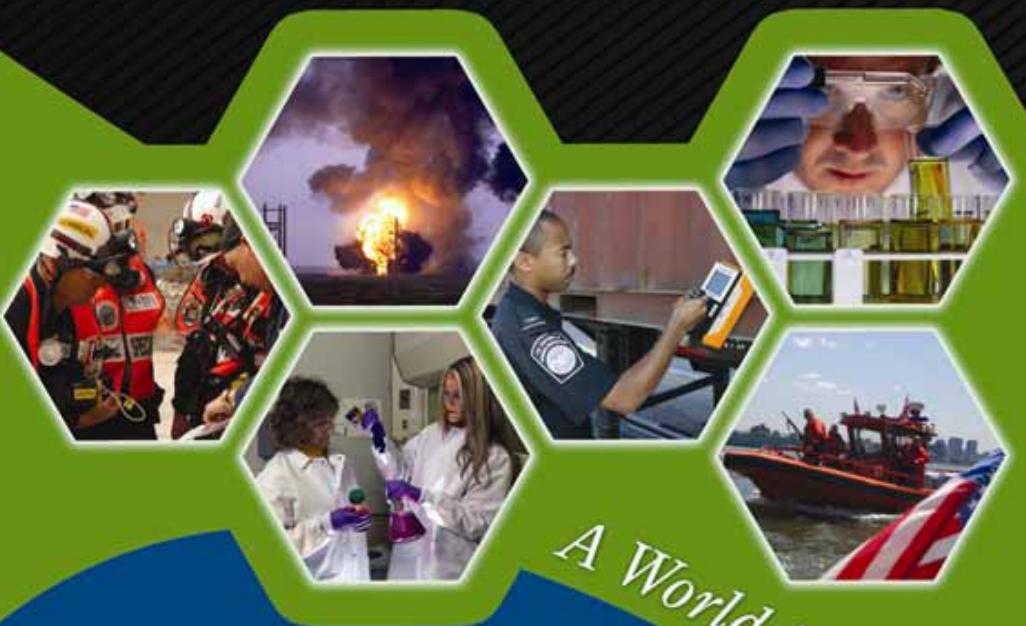
People Screening: Representative Technology Needs

- Systematic collection and analysis of information related to understanding terrorist group intent to engage in violence (*Human Factors Division*)
- Non-invasive monitoring: Identifying and tracking unknown or potential threats from individuals at key checkpoints. Real-time detection of deception or hostile intent through integrated system of human and machine methods (*Human Factors Division*)
- Capability in real-time for positive verification of individual's identity utilizing multiple biometrics (*Human Factors Division*)
- Capability for secure, non-contact electronic credentials; contactless readers or remote interrogation technologies for electronic credentials (*Human Factors Division*)
- Mobile biometrics screening capabilities, to include hand-held, wireless, and secure devices (*Human Factors Division*)
- High-speed, high-fidelity ten-print capture capability (*Human Factors Division*)



**Homeland
Security**

**2007 HOMELAND SECURITY
S&T Stakeholders
CONFERENCE**



May 21-24, 2007

**Ronald Reagan Building
Washington, D.C.**

Presented by:
NDIA
NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
NDIA
STRONGER THROUGH INDUSTRY & TECHNOLOGY

FROM SCIENCE...SECURITY - FROM TECHNOLOGY...TRUST

**2007 S&T
Stakeholders
Conference
Washington, DC**

For more information visit:
<http://www.ndia.org/meetings/7680>

Coming Up...
DHS S&T Conference
London - Dec. 4, 2007
Details to follow

Security challenges from the perspective of a small city state

PACOM Operational S&T Conference 2007

3 Apr 2007

Richard Lim, Rear Admiral (Retired) RSN
Chief Executive
Defence Science and Technology Agency

Singapore has enjoyed 42 years of peace and economic progress as an independent nation



Key contributors to success:

- A diversified and open economy plugged into the global marketplace
- A strong commitment to defence and security (6% GDP)
- Social and religious harmony

**But the
fundamentals
behind its security
challenges remain
basically
unchanged since
independence in
1965**





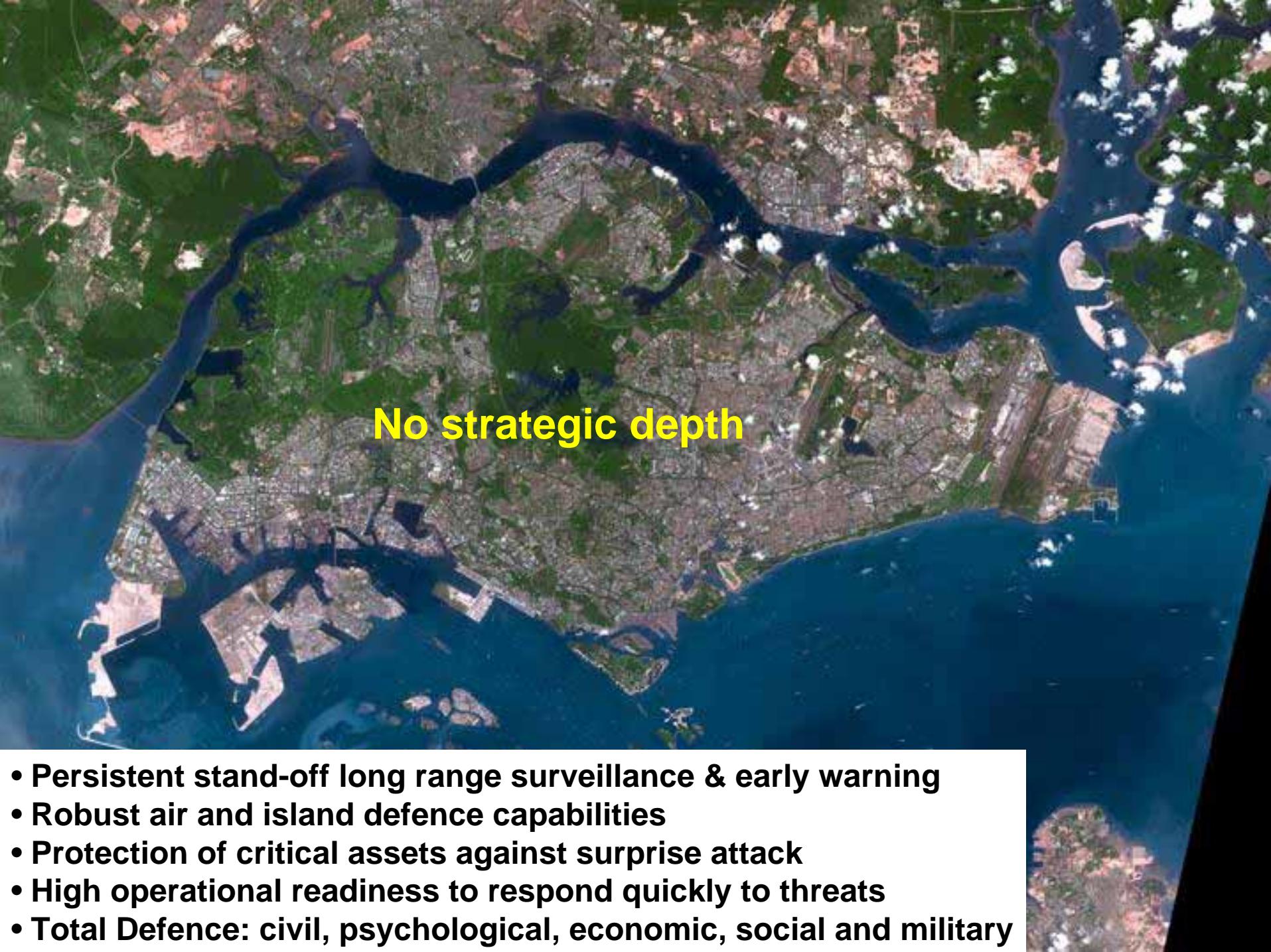
- No strategic depth
- Small population
- Limited space for military training

Singapore

- Area = 707 sq km (22% reclaimed)
- 42 km length; 23 km breadth
- Population = 4.3m (3.2m citizens)

New York City

- Area = 785 sq km
- Population = 8 million



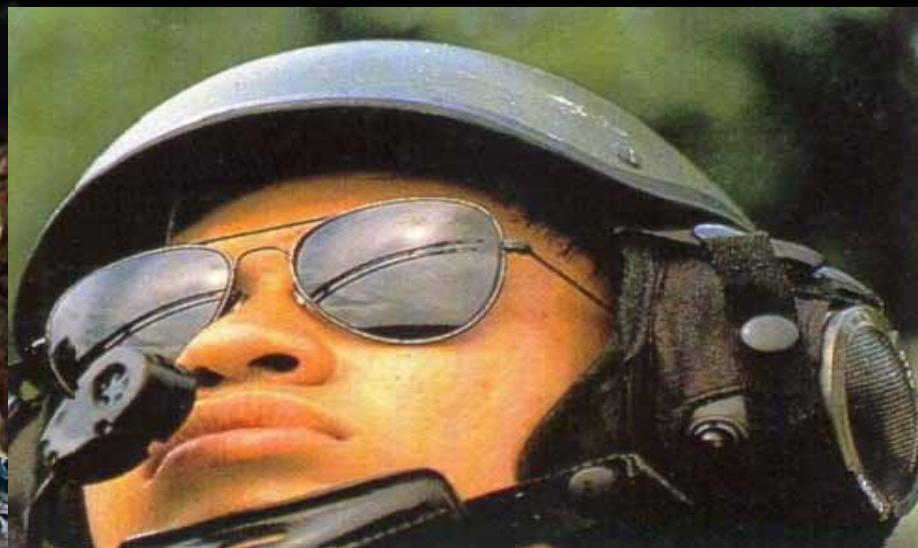
No strategic depth

- Persistent stand-off long range surveillance & early warning
- Robust air and island defence capabilities
- Protection of critical assets against surprise attack
- High operational readiness to respond quickly to threats
- Total Defence: civil, psychological, economic, social and military

Small population

Conscript Armed Forces

Two years of national service
300.000 when mobilised



Limited space for military training

Overseas Training



UNITED
STATES



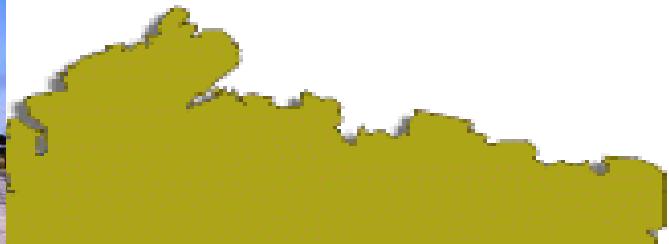
FRANCE



THAILAND



S. AFRICA



BRUNEI



AUSTRALIA
NEW ZEALAND



Our security challenges have become more complex



**The very elements that enable our success and prosperity
have become key vulnerabilities**



Changi Airport

**80 airlines with more than 4000 flights
connecting to more than 180 cities in 57 countries
35 million passenger and
214 thousand aircraft movements in 2006**

The very elements that enable our success and prosperity
have become key vulnerabilities



60 thousand vehicles pass
through the causeway each
day

8.94 million tourists arrivals

The very elements that enable our success and prosperity
have become key vulnerabilities

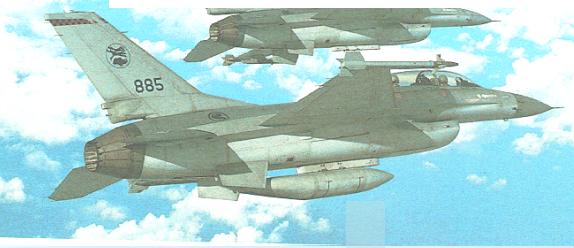


Singapore Port

200 shipping lines with links to 600 ports in 120 countries
140,000 vessels call annually
24 million containers (TEU) or 6% of global container throughput handled in 2006

SINGAPORE ARMED FORCES

While architected for deterrence and the defence of Singapore, the SAF has found itself deployed for various operations other than war



Peace Support Operations

- Singapore is committed to the UN and its mission in maintaining international peace and security
- 1500 SAF peacekeepers sent to various missions since 1989
- Operating out of traditional areas
 - East Timor
 - Middle East: Iraq and Afghanistan

Participation in UN PSO

| UN Mission | Date | Role(s) in Mission |
|---|----------------------|---|
| UNTAG, Namibia | Oct to Nov 89 | Election Supervisors |
| Ops Nightingale | Jan to Mar 91 | Medical Team |
| UNIKOM, Iraq-Kuwait | Apr 91 to Mar 03 | Military Observers |
| UNAVEM II, Angola | Jul 91 to Dec 92 | Military Observers |
| UNTAC, Cambodia | May to Jun 93 | Helicopter Detachment, Election Supervisors |
| UNOMSA, South Africa | Apr to May 94 | Election Supervisors |
| UN HQ – DPKO, New York | Nov 95 to Present | Appointments in DPKO |
| UNSCOM (UN Special Commission in Iraq) | Jun 96 | Member of UN Special Commission Inspection Team |
| MINUGUA, Guatemala | Feb to May 97 | Medical Team |
| UNSMA, Afghanistan | May 97 to May 98 | UN Military Adviser |
| International Force for East Timor (INTERFET) | 20 Sept 99 to Feb 00 | Medical Team, Military Liaison Teams |
| UN Transitional Administration in East Timor (UNTAET) | Feb 00 to May 02 | UNTAET HQ Staff, Medical teams and Peacekeeping troops |
| UN Mission in Ethiopia and Eritrea (UNMEE) | May 00 to Jul 03 | Military Observers |
| UN Mission of Support in East Timor (UNMIS) | May 02 to 22 Oct 03 | Force Commander, UNMIS HQ staff, Peacekeeping troops and Helicopter detachment 3 SAF PKF HQ Staff remain till May 04 |

Timor Leste

- **INTERFET**

- 4- men Liaison Team
- 3 x LST for 2 months each
- 1 x C130 for two weeks
- 26- personnel Medical Team
- 40 police personnel
- Cumulative total of 373 personnel involved



- **UNTAET**

- 4 x PKO HQ staff,
- 3 x 61-men Platoon Task Force in Western Sector
- 9 x 21-men Medical Team
- 40 x Police Personnel

- **UNMISSET**

- May 02 onwards - Over 250 personnel
- Force Comdr UNMISSET- PKF
- Staff Planners at PKF HQ

- Helicopter Detachment - 4 x UH1H

- Infantry Company



OEF / OIF



LST



KC-135



C-130

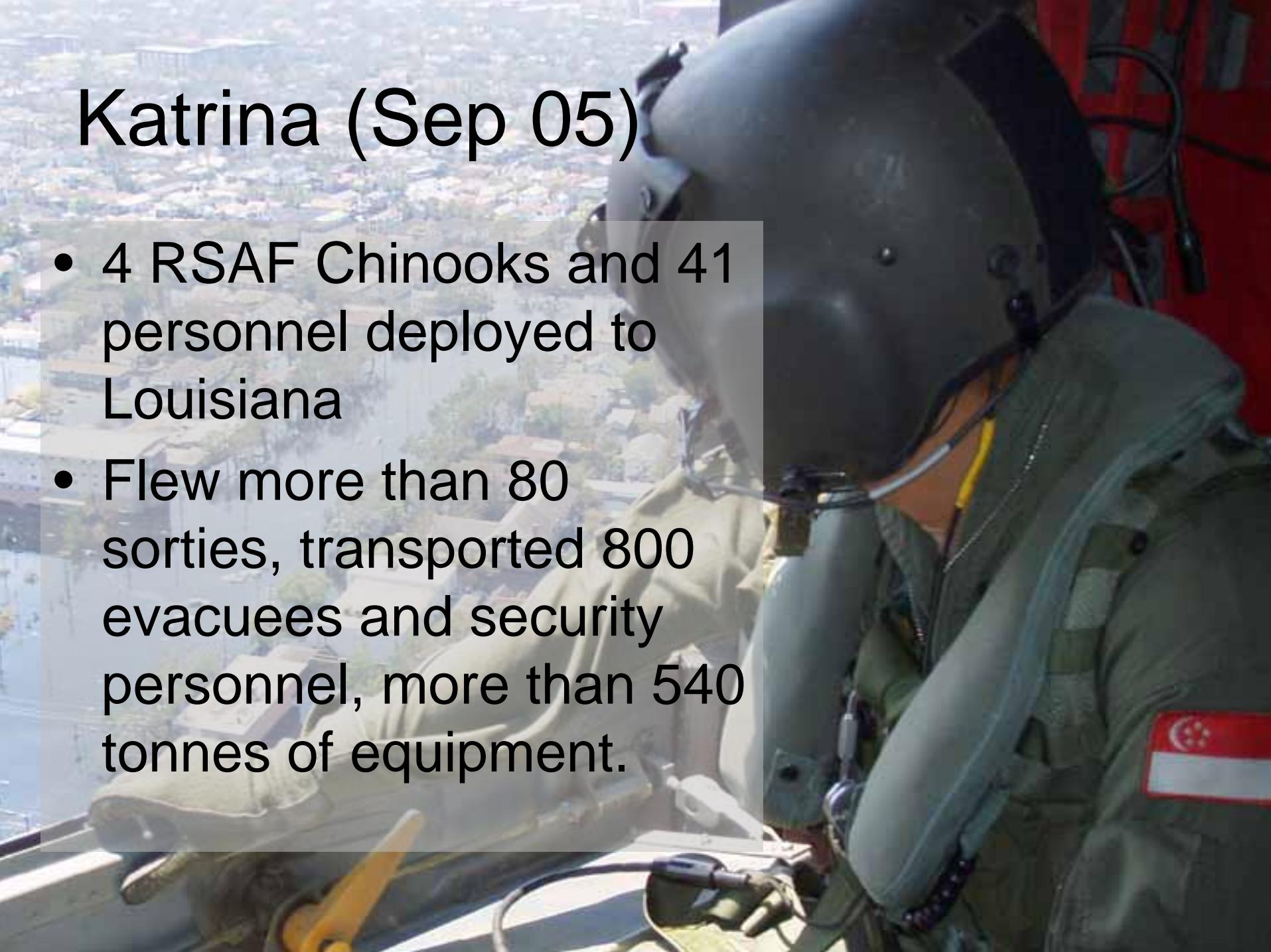
- **Landing Ship Tank (LST)**
 - Monitor vessels to and from ports in Iraq
 - Compliant boarding operations
 - Health and comfort support to detained vessels
 - Platform support for helicopter operations
 - Guardship duties
- **KC-135**
 - Air-to-air refuelling
- **C130**
 - Strategic lift for personnel and cargo
 - Aeromedevac

Indian Ocean Tsunami



Katrina (Sep 05)

- 4 RSAF Chinooks and 41 personnel deployed to Louisiana
- Flew more than 80 sorties, transported 800 evacuees and security personnel, more than 540 tonnes of equipment.



Yogyakarta Earthquake

(27 May 06)

- Medical detachment deployed
 - TNI Field Hospital in Plered, Bantul
 - Bantul District Hospital
- US\$250,000 worth of humanitarian supplies (approx 24 tons)
 - 750 tentages
 - 4,200 blankets
 - 400 cot beds
 - 1,300 sleeping bags
 - Medical supplies



Provincial Reconstructive Team

Bamiyan, Afghanistan

- Part of New Zealand Reconstruction Team
- Set up of dental clinic & training of locals in dentistry and basic healthcare
- Bridge construction and repair work

Support for Homeland Security

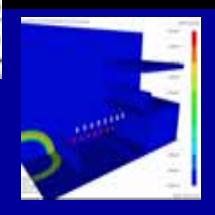


Maritime C3 and Coastal Surveillance

Police/SCDF C3



Explosive Testing

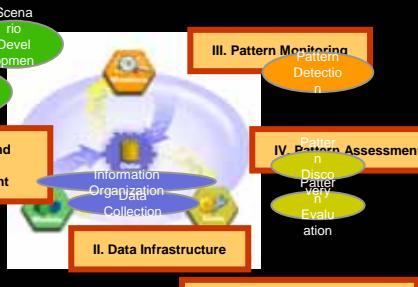


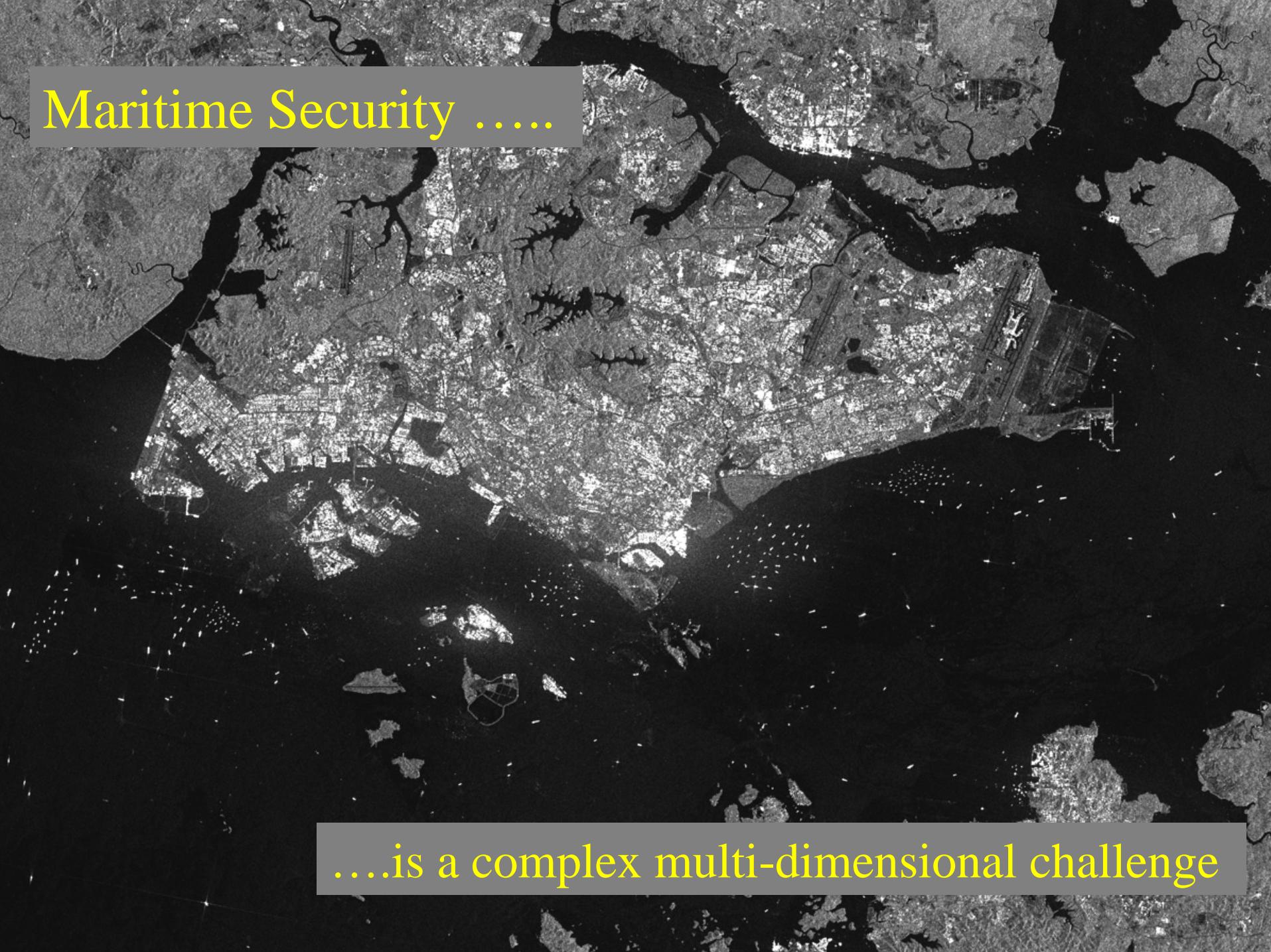
Crisis Information Management



Infrastructure Hardening

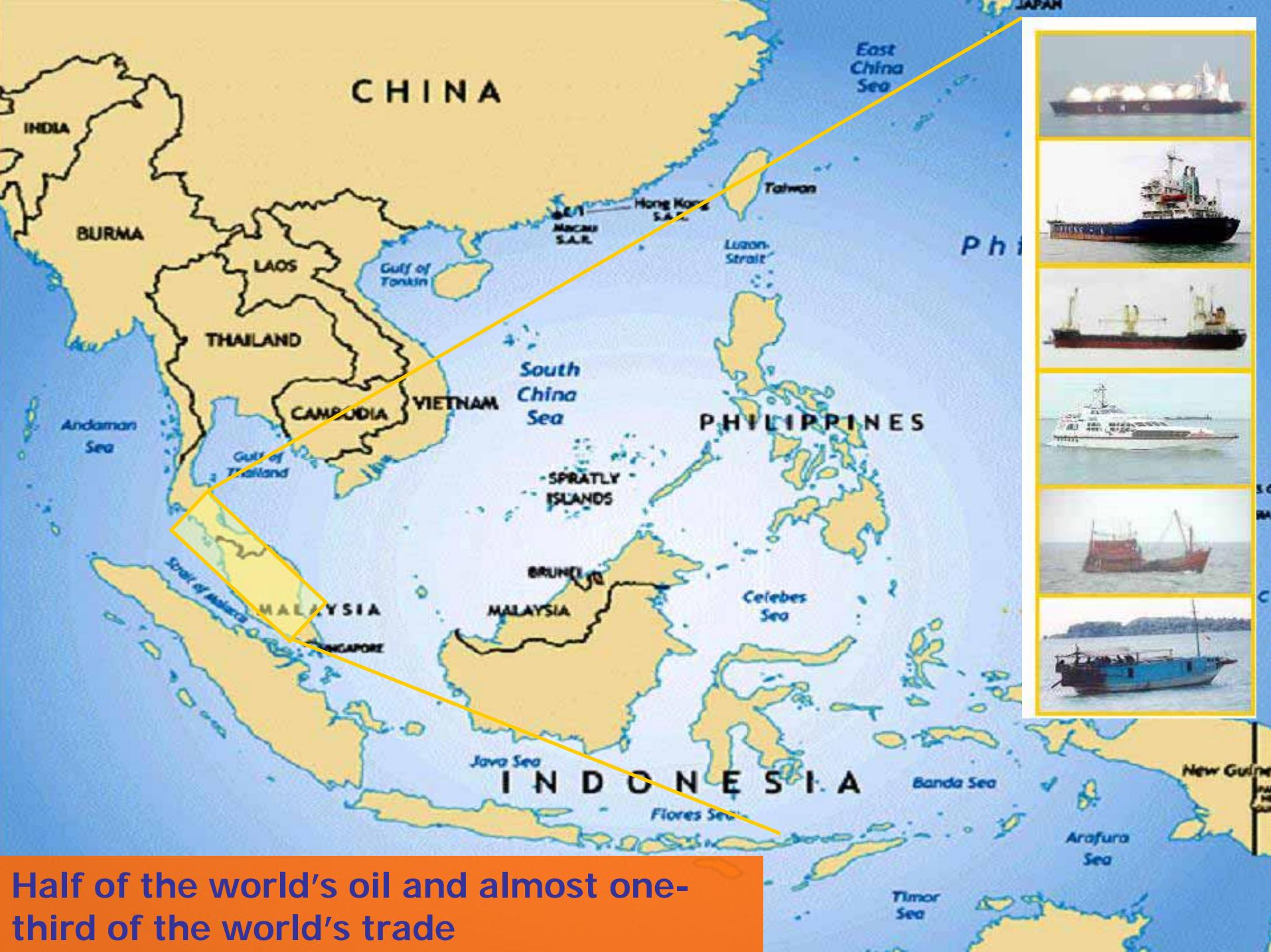
Risk Assessment Horizon Scanning





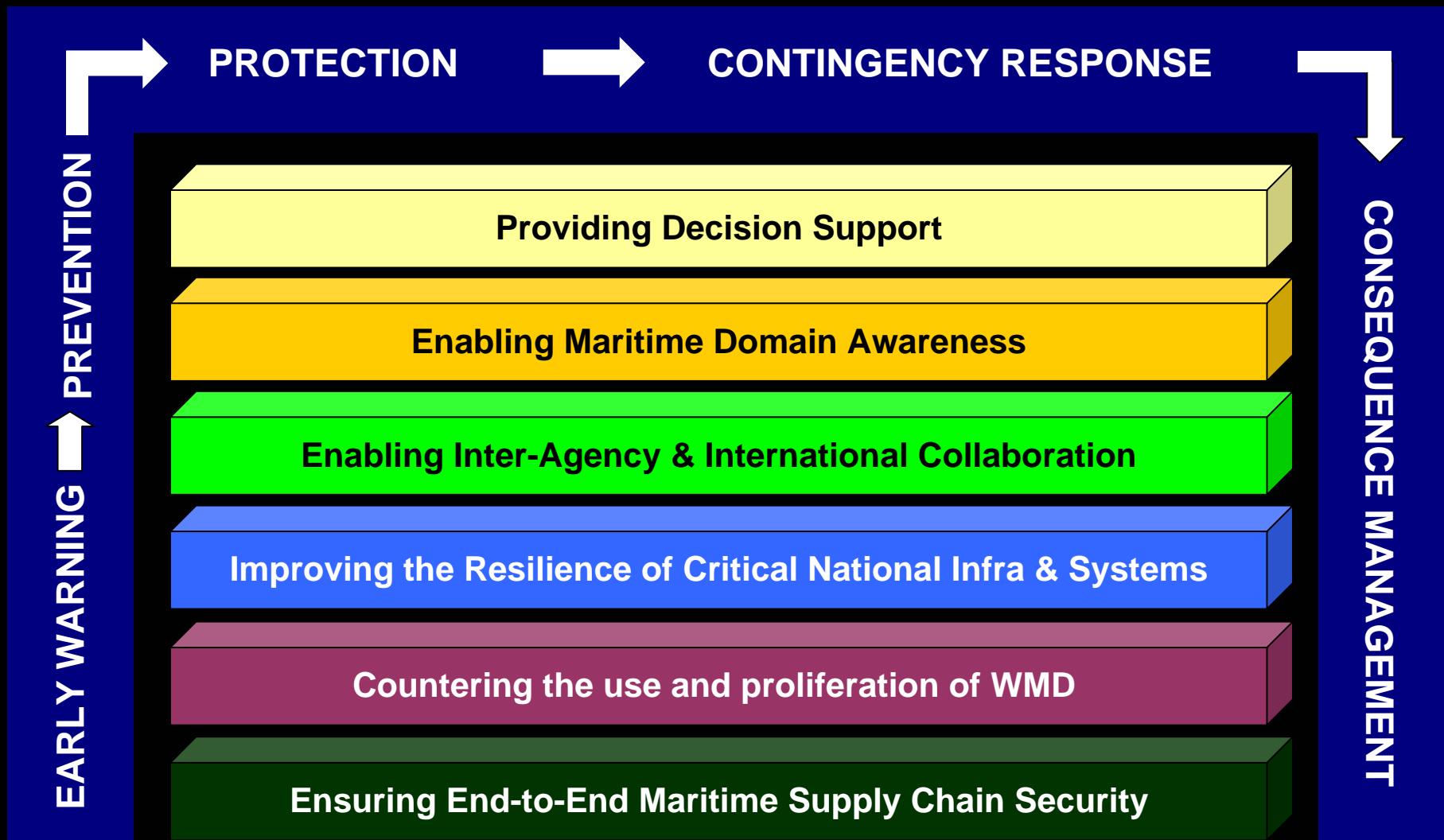
Maritime Security

....is a complex multi-dimensional challenge



Half of the world's oil and almost one-third of the world's trade

Technology support in



EARLY WARNING → PREVENTION

PROTECTION

CONTINGENCY RESPONSE

CONSEQUENCE MANAGEMENT

Providing Decision Support



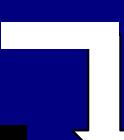
- Vulnerability and risk assessments of critical infrastructure

EARLY WARNING → PREVENTION

PROTECTION



CONTINGENCY RESPONSE



CONSEQUENCE MANAGEMENT

Enabling Maritime Domain Awareness



Video mosaic

EARLY WARNING → PREVENTION

PROTECTION

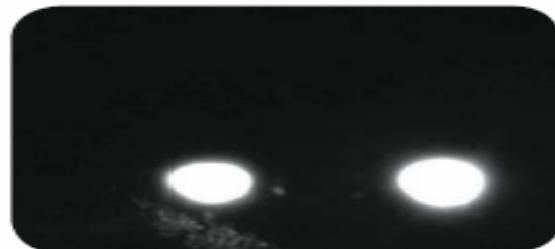
CONTINGENCY RESPONSE

CONSEQUENCE MANAGEMENT

Enabling Maritime Domain Awareness

Passive mode

Distance 750 m



Laser on

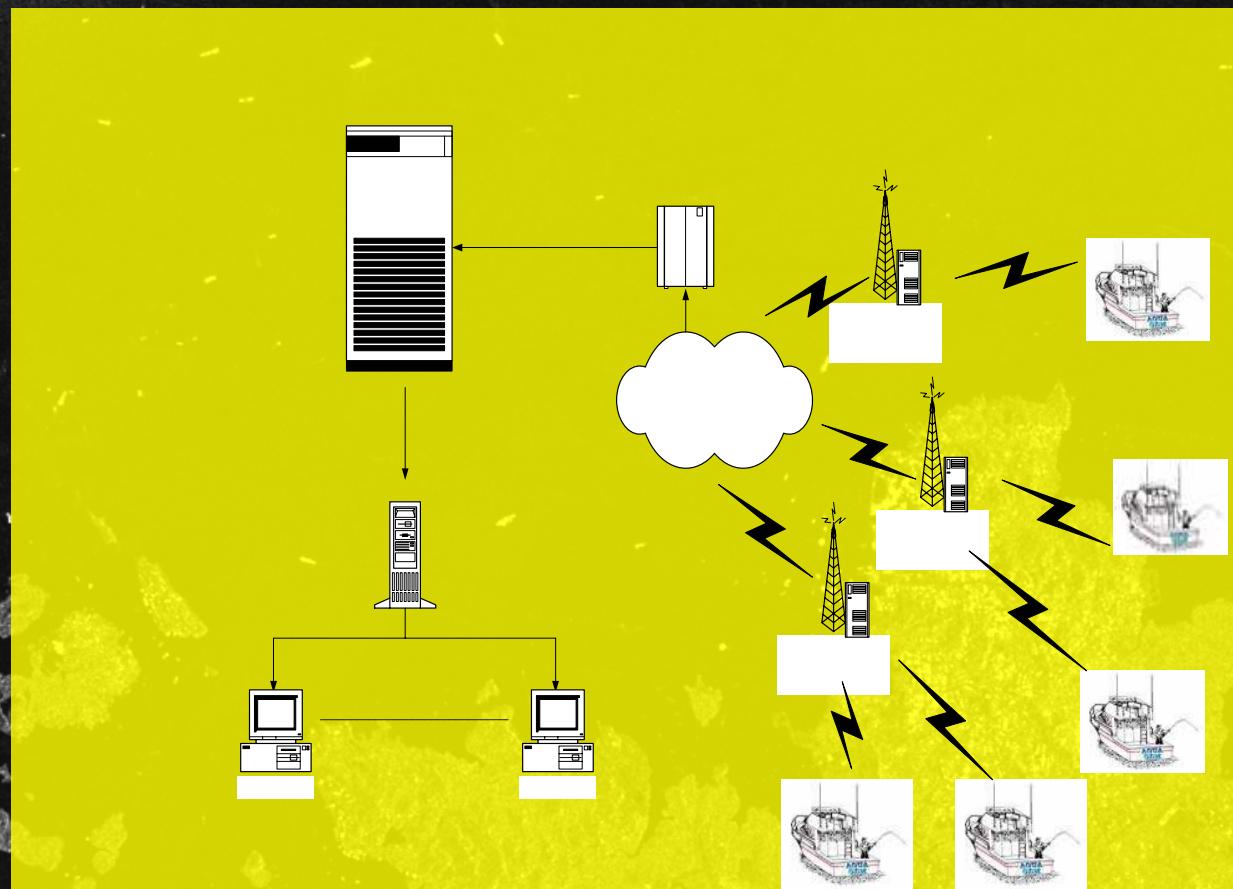


Distance 1.4 km

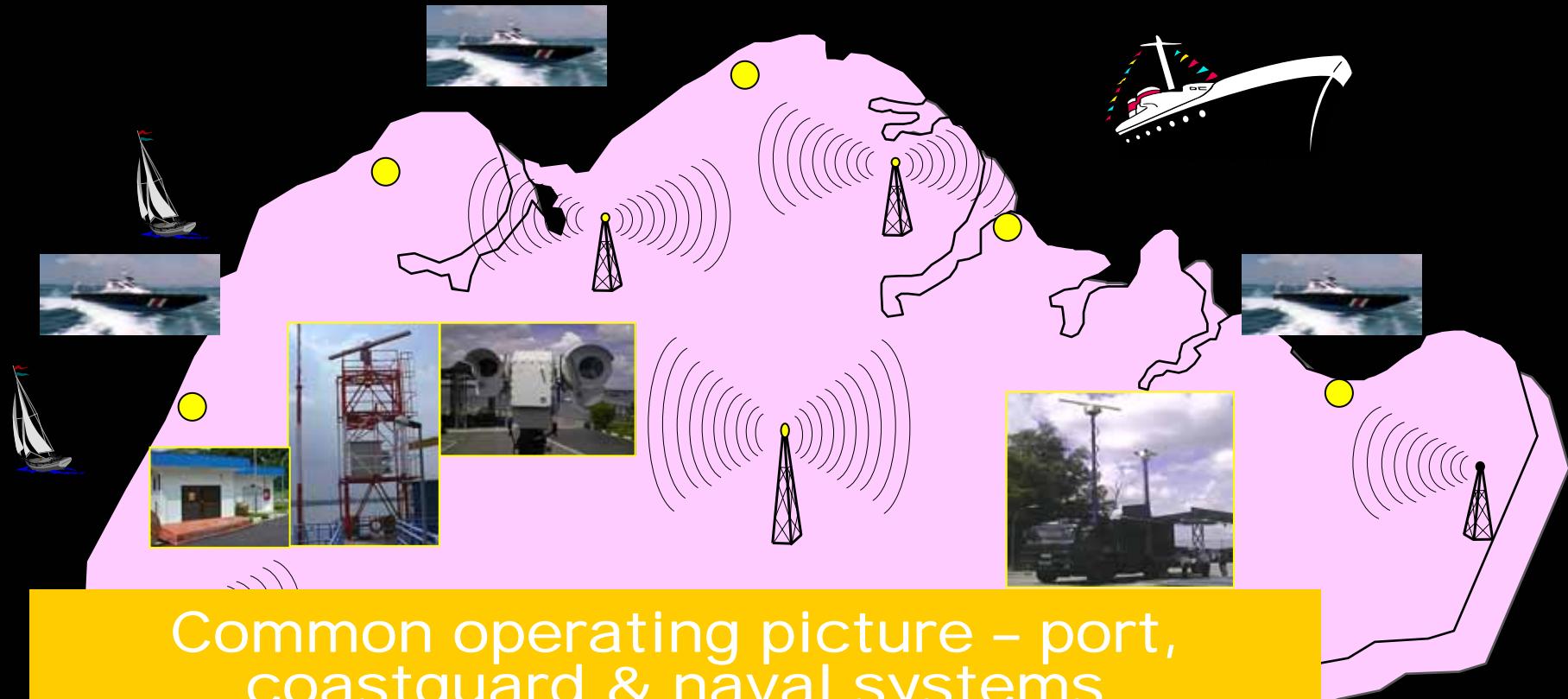


Active imaging

Harbour Craft Transponder System



Enabling Inter-Agency & International Collaboration



Enabling Inter-Agency & International Collaboration



- Promote interoperability with international forces

CHANGI C2 CENTRE

Enhancing Resilience of Critical National Infra & Systems



Port Security Booms

Enhancing Resilience of Critical National Infra & Systems



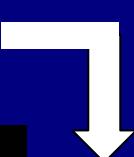
Explosive effects testing

EARLY WARNING → PREVENTION

PROTECTION

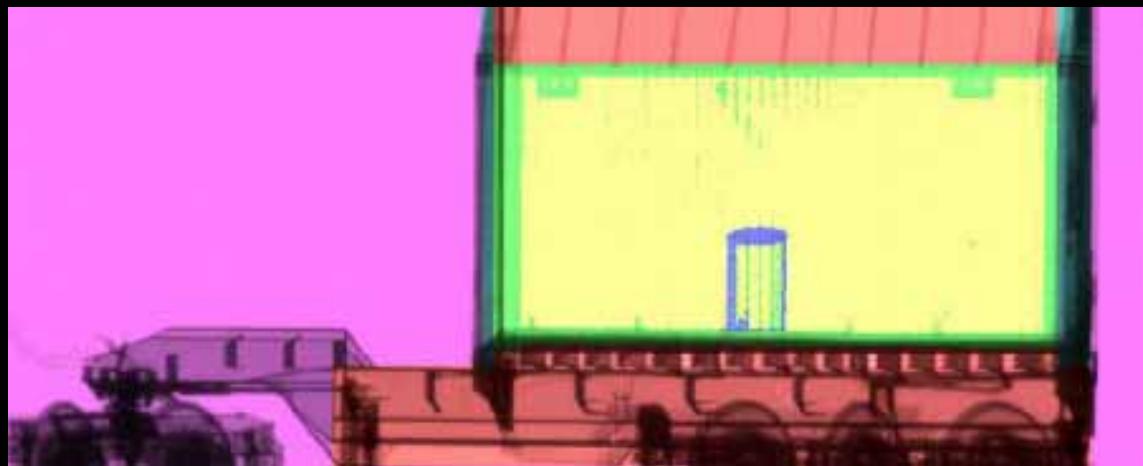


CONTINGENCY RESPONSE



CONSEQUENCE MANAGEMENT

Countering the use and proliferation of WMD



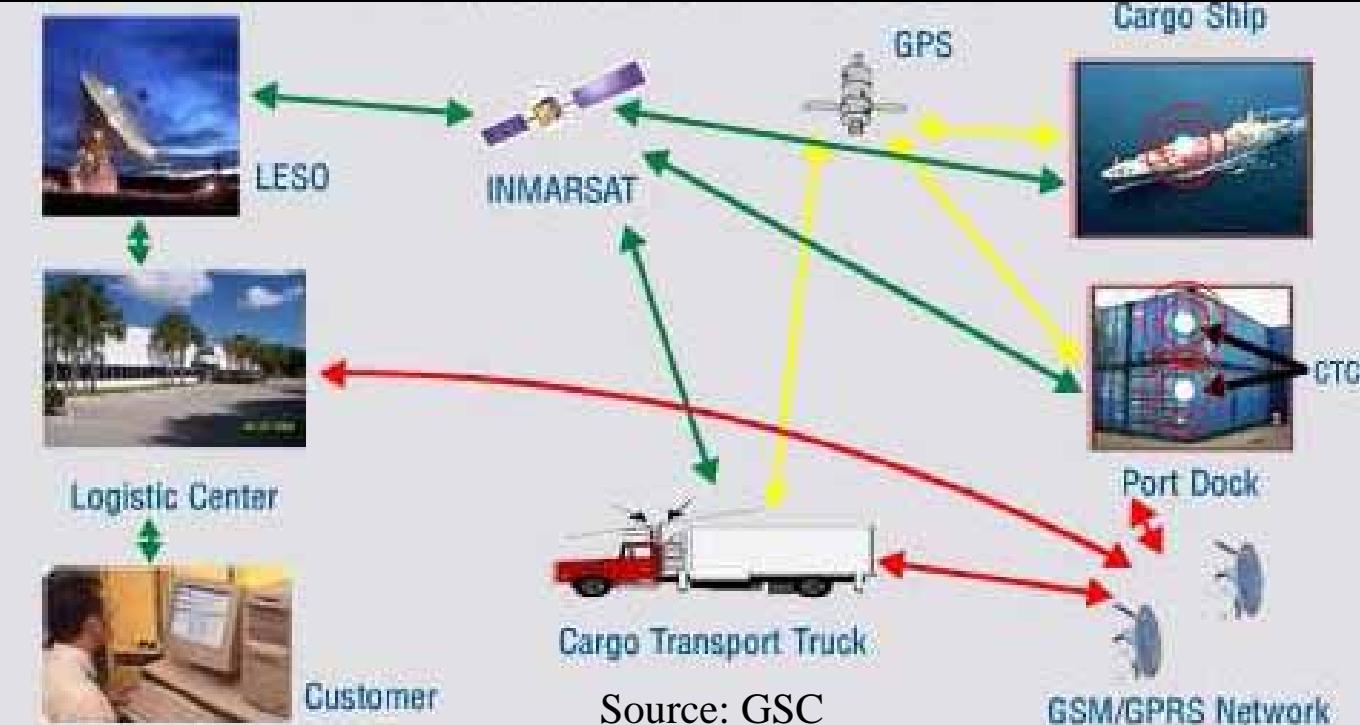
EARLY WARNING → PREVENTION

PROTECTION

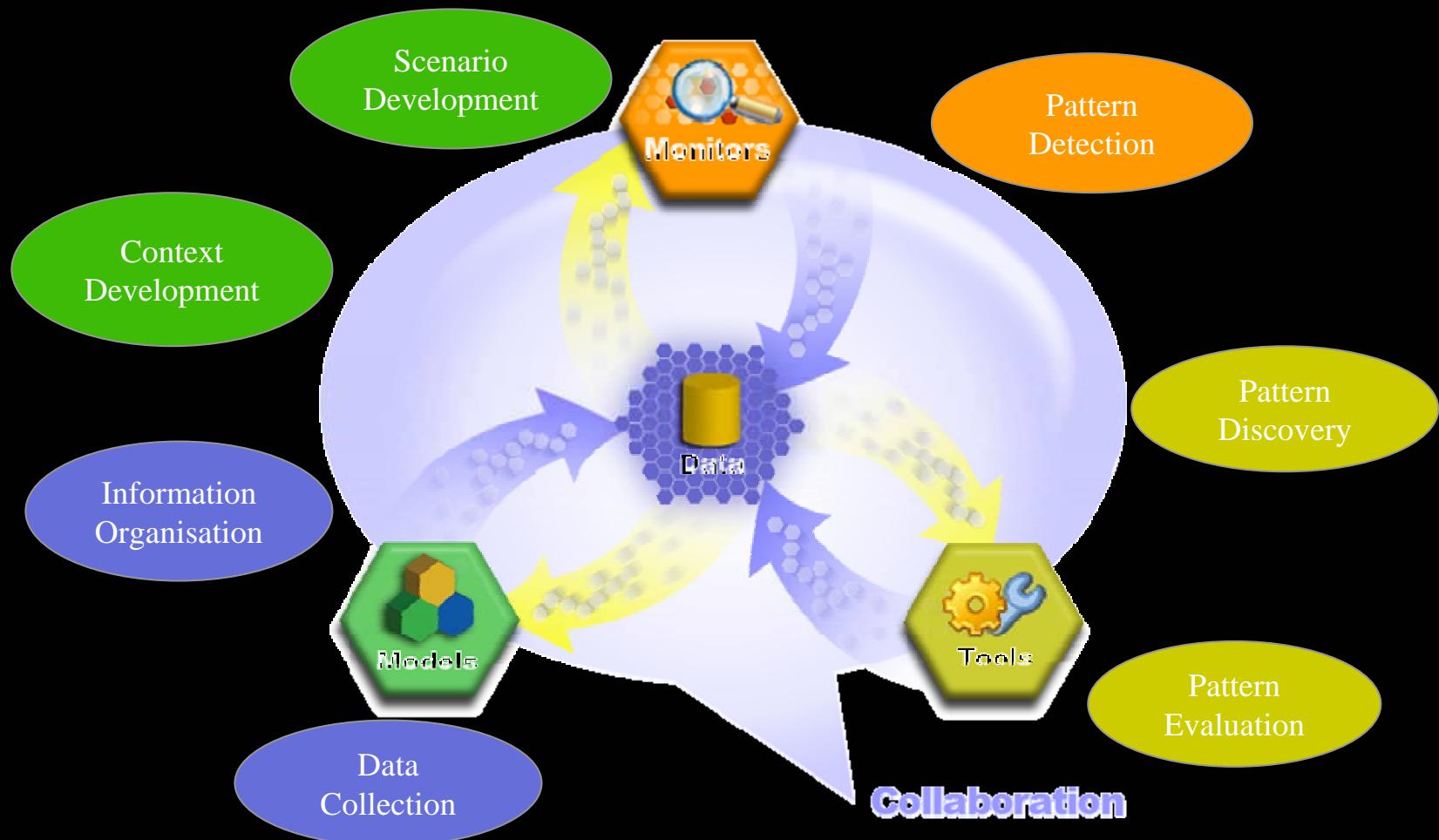
CONTINGENCY RESPONSE

CONSEQUENCE MANAGEMENT

Ensuring End-to-End Maritime Supply Chain Security



Risk Assessment & Horizon Scanning (RAHS)



International collaboration

A close-up photograph of two people's hands clasped together in a firm handshake. The hands are positioned over a small, colorful globe that shows continents in shades of brown, tan, and green. The background is blurred, showing hints of purple and blue, suggesting an indoor setting like a conference room.

FPDA (Five Power Defence Arrangements)



INDO-SIN Co-ordinated Patrols (ISCP)



Malacca Strait Patrols

- Malacca Strait Sea Patrols (MSSP)
- Eyes in the Sky (EiS)



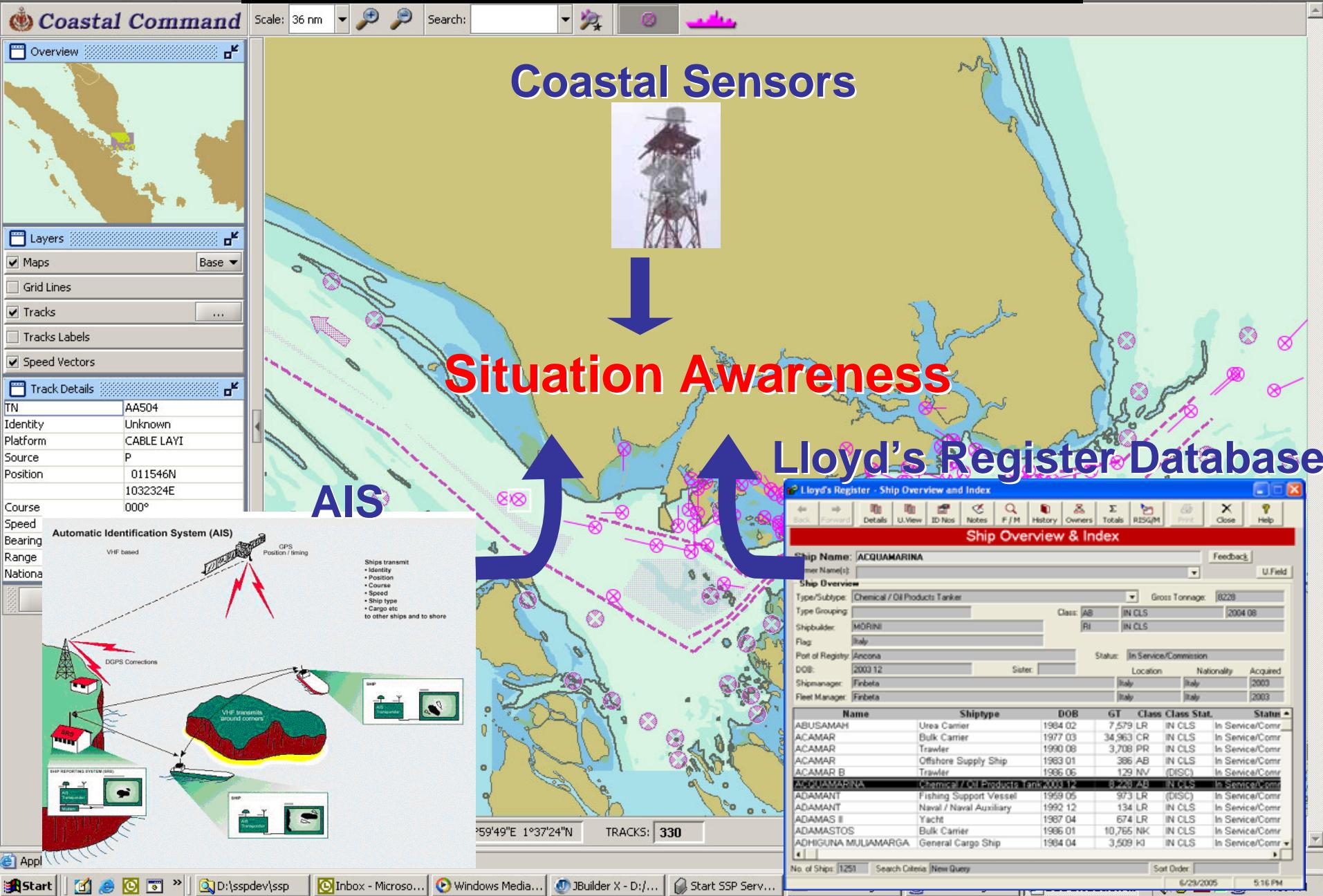


Exercise Deep Sabre 05

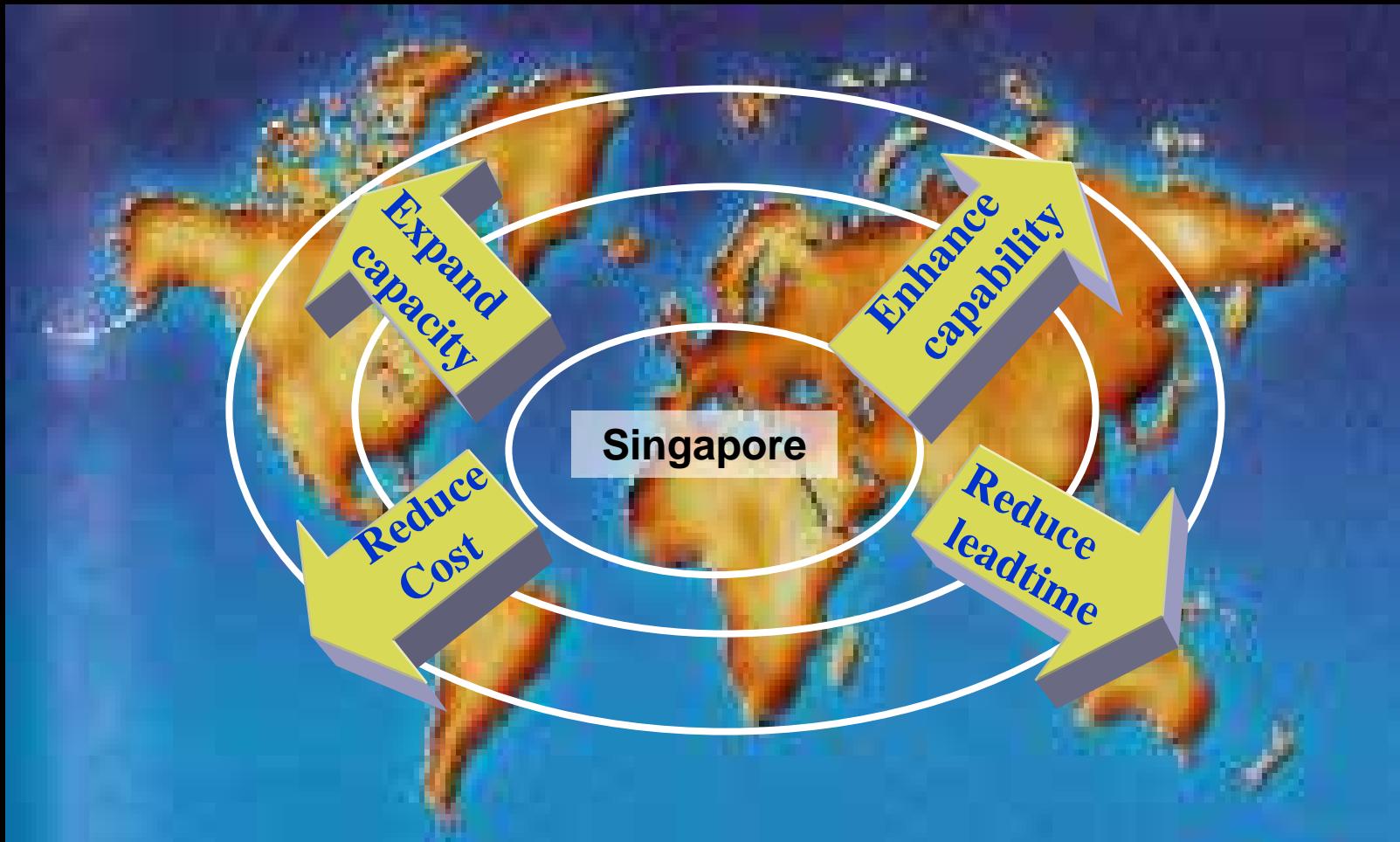
- Singapore-hosted, first PSI exercise in Southeast Asia.
- Distinct Features:
 - Table Top Exercise (TTX)
 - Maritime Interdiction Operations
 - Combined Co-ordination Centre
 - Port Search Phase
 - Exercise Debrief Session



CMA JCTD with PACOM



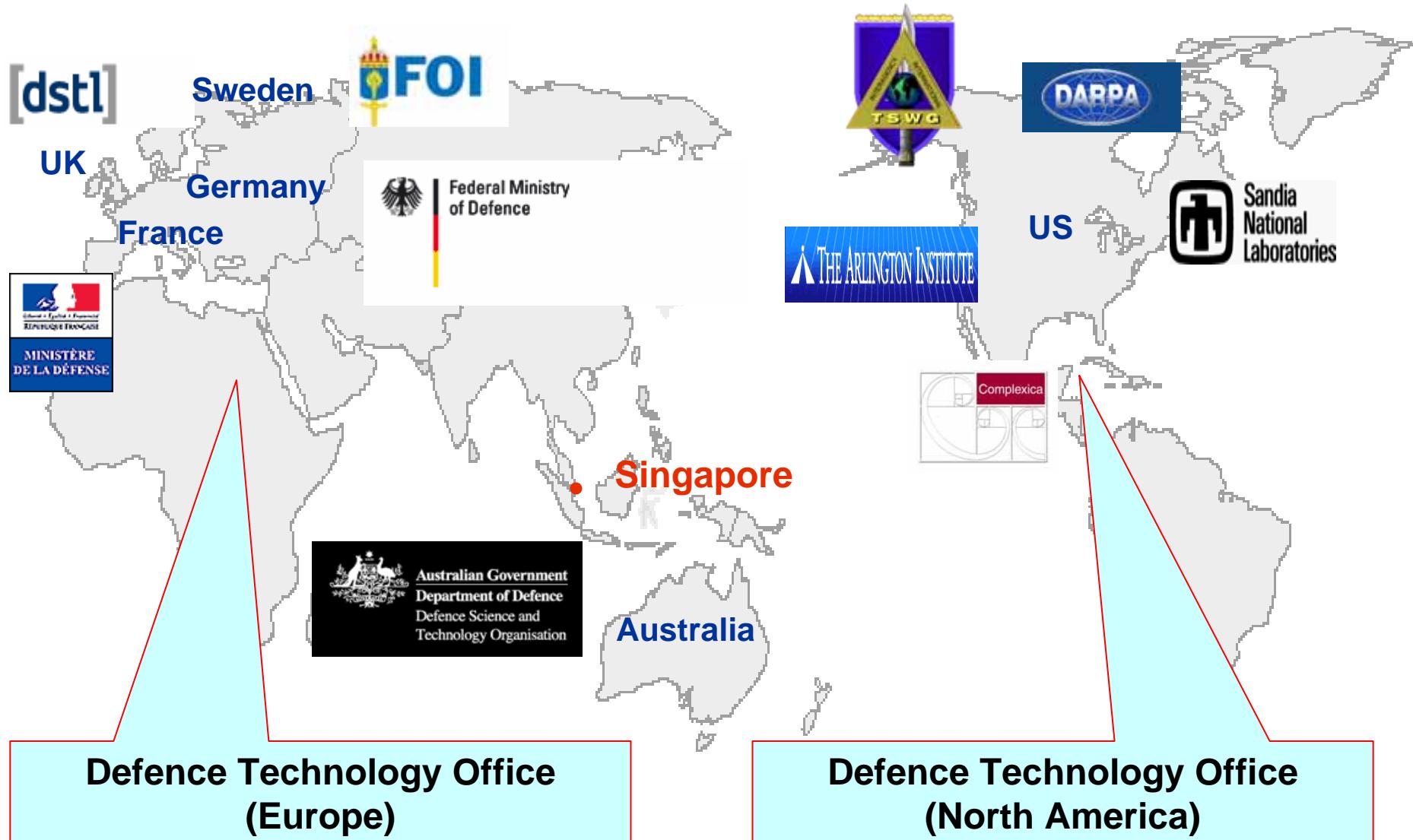
Technology Collaboration



Our S&T Partners



International Collaboration



Conclusion

- Singapore takes a systems level approach with technology as an enabler to meet the complex security challenges we face today
- Singapore participates in and seeks international collaboration to meet these challenges

Thank You



NR

Revolutionary Research . . . Relevant Results



Naval Science and Technology Update

PACOM Science and Technology Conference

4 April 2007





A Technological “Perfect Storm”?

For decades, Western militaries have held a decisive technological advantage...



“It is by devising new weapons, and above all by scientific leadership, that we shall best cope with the enemy’s superior strength.”

--Winston Churchill

Today, enemies are able to acquire weapons and technology quickly and cheaply...



“Acquiring weapons for the defense of Muslims is a religious duty. If I have indeed acquired these weapons, then I thank God for enabling me to do so. And if I seek to acquire these weapons, I am carrying out a duty. It would be a sin for Muslims not to try to possess the weapons that would prevent the infidels from inflicting harm on Muslims.”

--Osama bin Laden

And there also are nations willing to invest significantly in new technology...



“The 21st Century is also going to be an age of scientific change, with certain cutting-edge technologies likely to be applied to naval warfare...high-tech arms will make direct attacks on naval battlefields possible from outer space, remote altitudes and remote land bases...superconduction technology will bring superconductor ships to the naval order of battle, enabling ships to travel faster without noise...submarines will be able to go faster and deeper, with the seabed being the ideal place to build military bases.”

--Chinese Naval Officers at the Navy Research Institute in Beijing



Technological Dominance



**Laser-Guided
Munitions**



**GPS Navigation and
Targeting**



**Mobile
Communications**



**Network-Centricity,
Information Warfare,
and Intelligence**



Technological Democratization

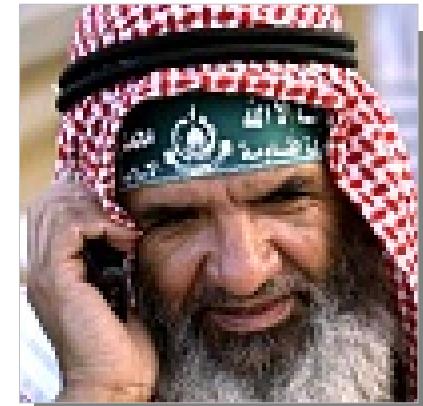


**Internet—
Information Warfare
and Intelligence**



**Commercial Laser
Rangefinder—Precise
Targeting**

In Afghanistan, Iraq, and elsewhere, our adversaries are leveraging sophisticated technology that is now easily available anywhere in the world—and at modest cost.



**Cell Phones—
Mobile Comms**



**Handheld GPS—
Location with
Extreme Accuracy**

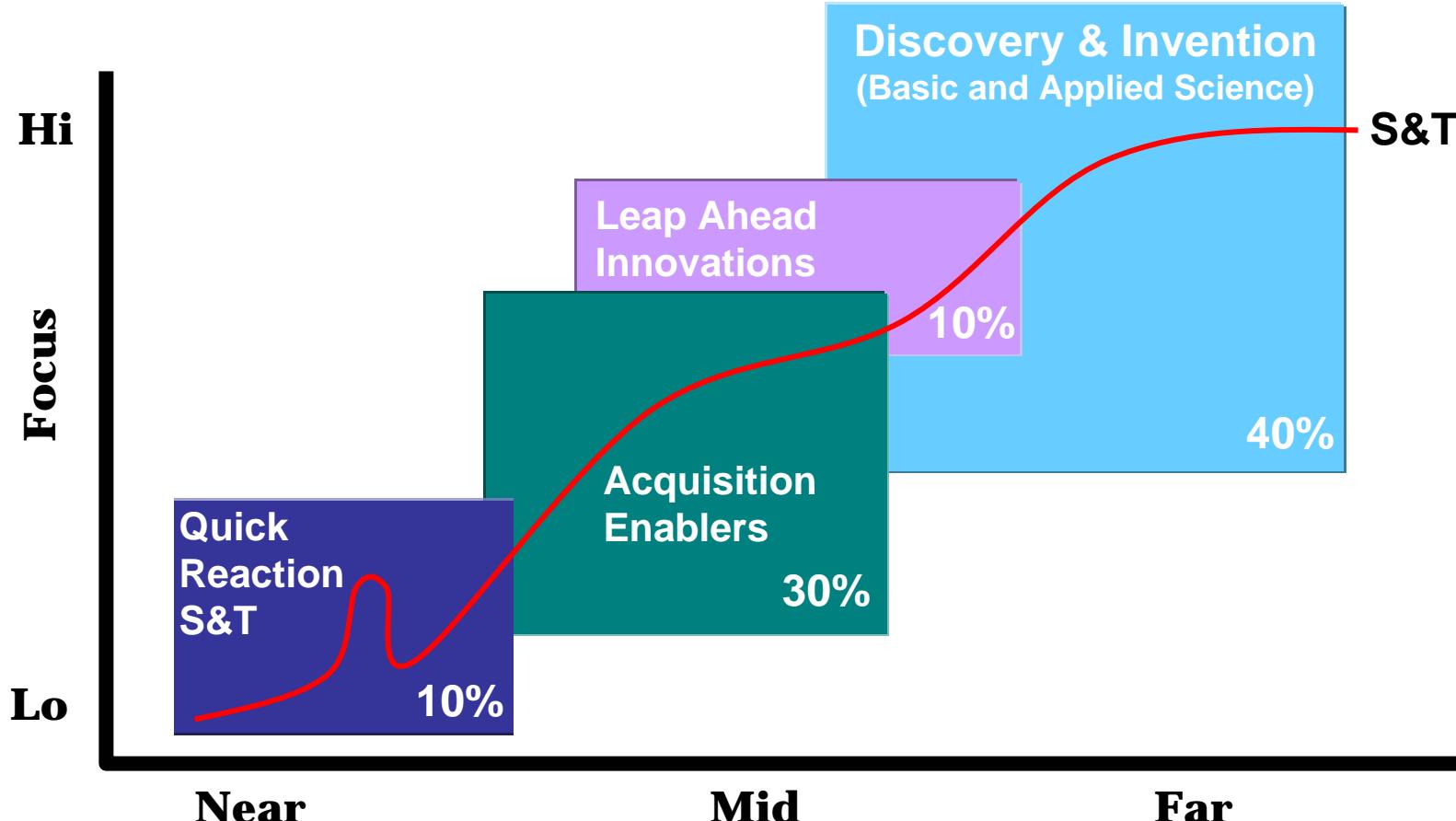


S&T Strategy Objectives

- Ensure alignment of Naval S&T with Naval missions and future capability needs
- Balance and manage S&T portfolio based on key tenets:
 - Strive to engage with intellectual capital worldwide
 - Leverage U.S. and global technology insights
 - Maintain equilibrium between long-term basic research and near-term advanced prototyping
 - Be innovative and adaptive—lead science where it is critical to the Navy/Marine Corps vision
 - Leverage technology development efforts across the entire DoD
- Communicate S&T vision and approach to senior decision makers, key stakeholders, S&T partners, customers, and performers



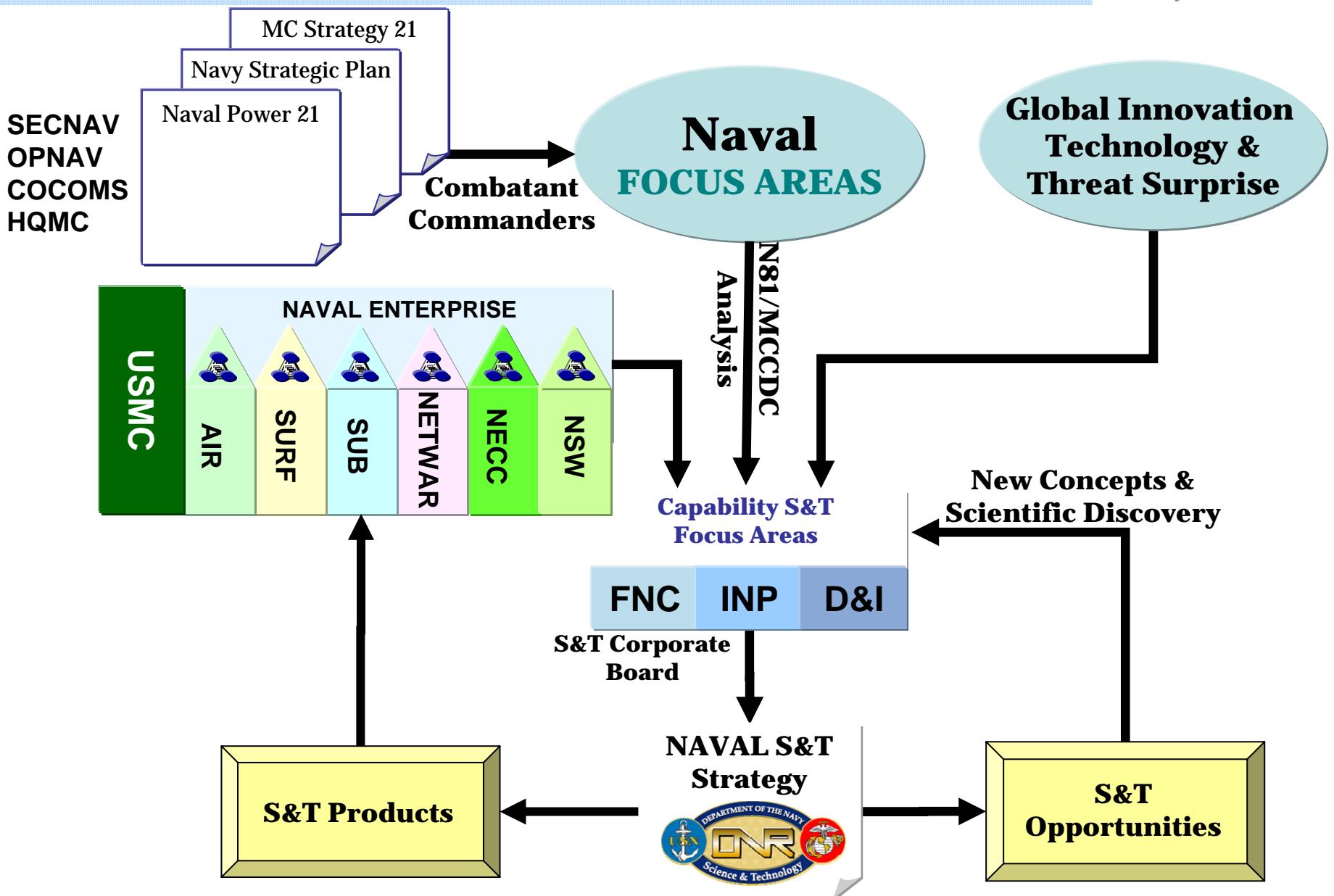
ONR S&T Portfolio Balance



S&T has a long-term focus but is responsive to near-term Naval needs



Naval S&T Strategy Process

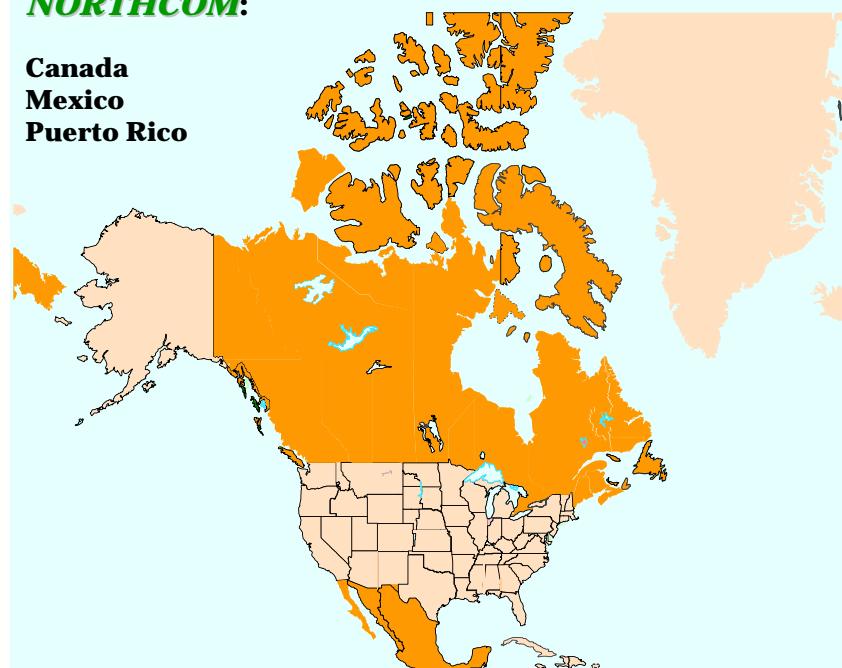




International Engagement

NORTHCOM:

Canada
Mexico
Puerto Rico



SOUTHCOM:

Argentina
Brazil
Chile
Columbia
Panama
Peru
Uruguay



EUCOM:

Norway
Sweden
Finland
Denmark
U.K.
Ireland
Netherlands
Belgium

France
Spain
Portugal
Germany
Italy
Czech Rep

Slovakia
Hungary
Austria
Tunisia

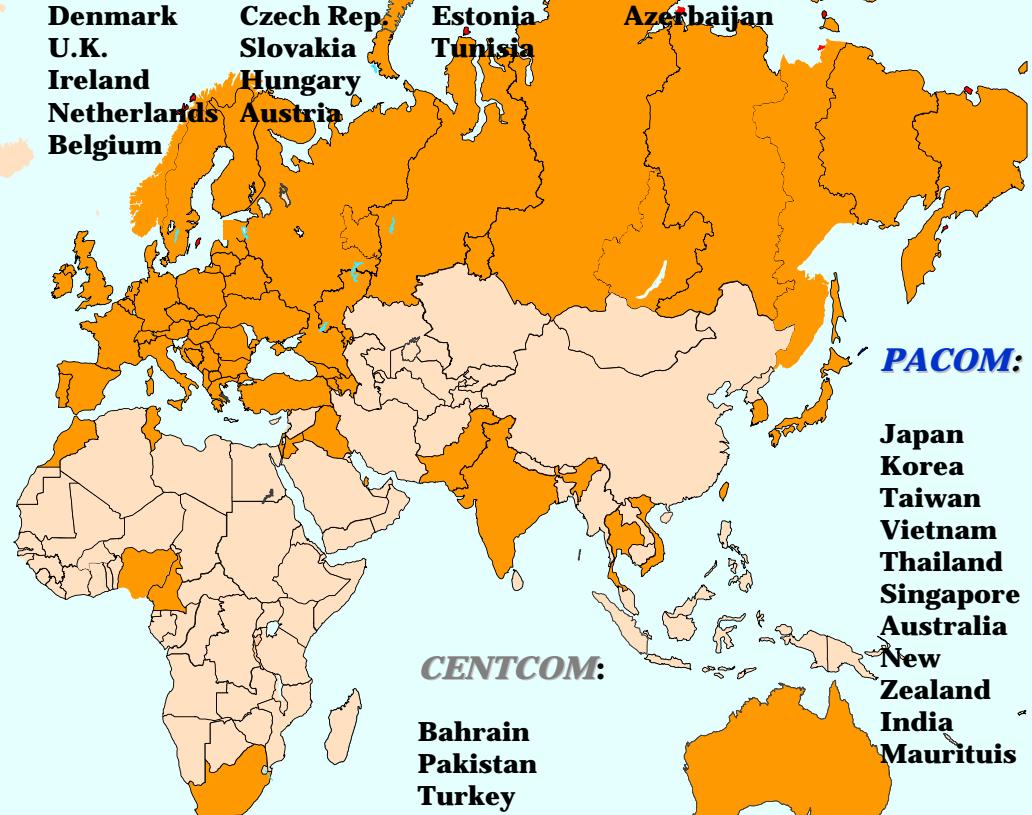
Slovenia

Poland
Romania
Bulgaria
Greece
Estonia

Russia
Armenia
Azerbaijan

Latvia
Lithuania
Ukraine

Morocco
Nigeria
Cameroon
Kenya
South Africa



PACOM:

Japan
Korea
Taiwan
Vietnam
Thailand
Singapore
Australia
New Zealand
India
Mauritius



CENTCOM:

Bahrain
Pakistan
Turkey
Iraq
Israel





Resulting Naval S&T Focus Areas

- **Power and Energy**
- **Operational Environments**
- **Maritime Domain Awareness**
- **Asymmetric & Irregular Warfare**
- **Information, Analysis and Communication**
- **Power Projection**
- **Assure Access and Hold at Risk**
- **Distributed Operations**
- **Naval Warrior Performance and Protection**
- **Survivability and Self-Defense**
- **Platform Mobility**
- **Fleet/Force Sustainment**
- **Affordability, Maintainability, and Reliability**



Assured Access and Hold at Risk

Vision: Attain maritime, littoral, and riverine access to denied areas and hold strategic and tactical targets at risk using lethal and non-lethal means.

Objectives

Anti-Submarine & Mine Warfare

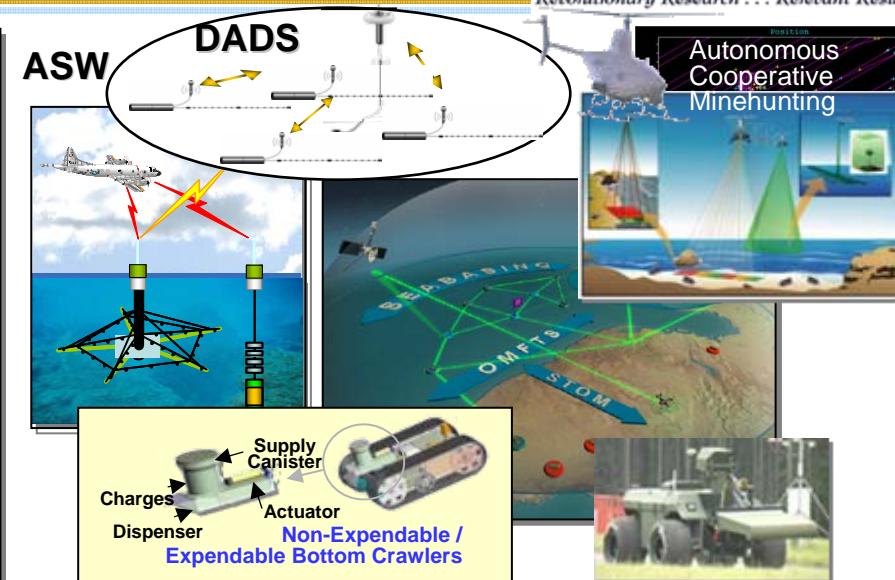
- Rapid Clearing and detection of mines
- Advanced autonomy in unmanned robotic systems to expand ground reach and reduce threat exposure
- Next generation data and contact fusion to expand the regional ASW, mine & amphibious warfare operating picture to the theater level

Distributed Surveillance

- Distributed, networked surface, ground, and underwater sensors
- Unmanned systems with onboard processing
- Autonomous Maritime Reconnaissance/Neutralization

Battlespace Shaping

- Non-lethal technologies to stop small vehicles and large ships
- Battlespace shaping technology for enabling information operations
- Decisive operations through a heavy EW attack area
- Access in GPS denied areas – Alternatives to GPS technology
- Operationally responsive use of space
- Tagging, Tracking, and Locating Technologies



Key Research Topics

- Anti-Submarine Warfare Surveillance
- Mine Hunting
- Unmanned Vehicles
- Intelligent and Autonomous Systems
- Networked Sensors
- Space Technologies
- Nanoscale Electronic Devices & Sensors
- Solid State Electronics
- Functional Materials
- EW – Attack
- ISRT - EM
- Large Vessel Stopping
- Non-Lethal Weapons
- Navigation and Precision-Timekeeping



Distributed Operations

Vision: Enable dispersed small units to dominate extended battlespace through advanced warfighter training, unambiguous situational awareness, robust communications and sense and respond logistics.

Objectives

Training

- Enhancement of Physical and Cognitive Performance
- Simulation – based scenarios for enhanced training
- Rapid assimilation of cultural environments

Communications

- Robust Command and Control networks
- Airborne relays on manned and unmanned platforms

Logistics

- Rapid re-supply and medical evacuation whenever possible
- Real-time automatic supply sensors and network
- Optimize medical self-sufficiency

Fires

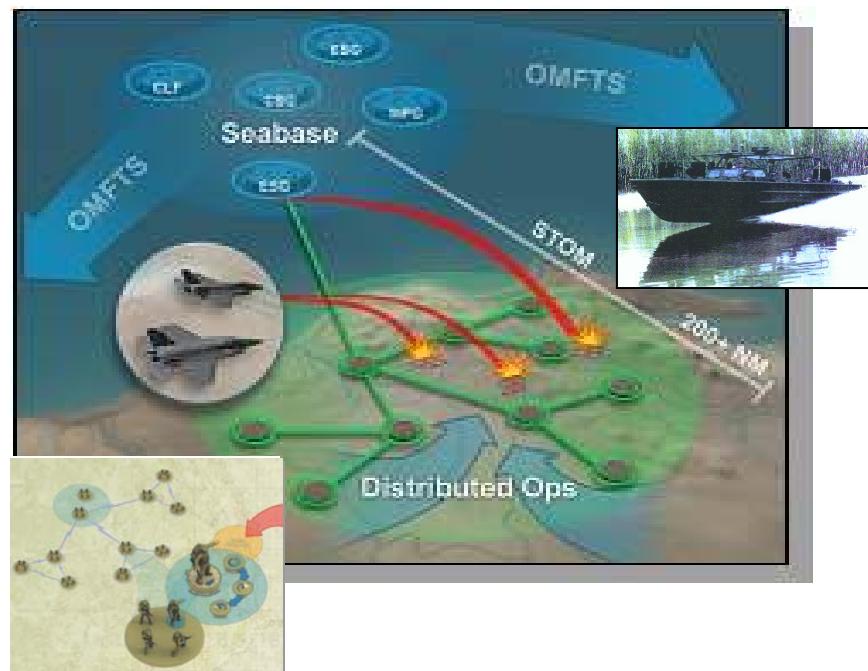
- Integrate firepower of distributed ground, offshore, and air assets
- Blue Force Tracking down to the individual

Survivability

- Warfighter stealth technology
- Warfighter exoskeleton technology

Maneuver

- Adaptable and survivable tactical mobility systems to enhance operational tempo and extend range of vehicles and soldiers
- Advanced materials to reduce combat load



Key Research Topics

Training, Education & Human Performance

Expeditionary C4

Communications and Networks

Expeditionary Logistics

Expeditionary Firepower

Precision Strike

Expeditionary ISR

Unmanned Air and Ground Vehicles

Special Warfare / EOD

Land Mine Countermeasures

Expeditionary Maneuver/ Individual Mobility



Survivability and Self-Defense

Vision: Enable manned and unmanned platforms to operate in any hostile environment and avoid/survive attack through innovative materials, sensors, countermeasures and counter-weapons.

Objectives

Platform Stealth

- Reduce above water and subsurface signatures
- Multi-spectral LO technologies

Countermeasures & Counterweapons

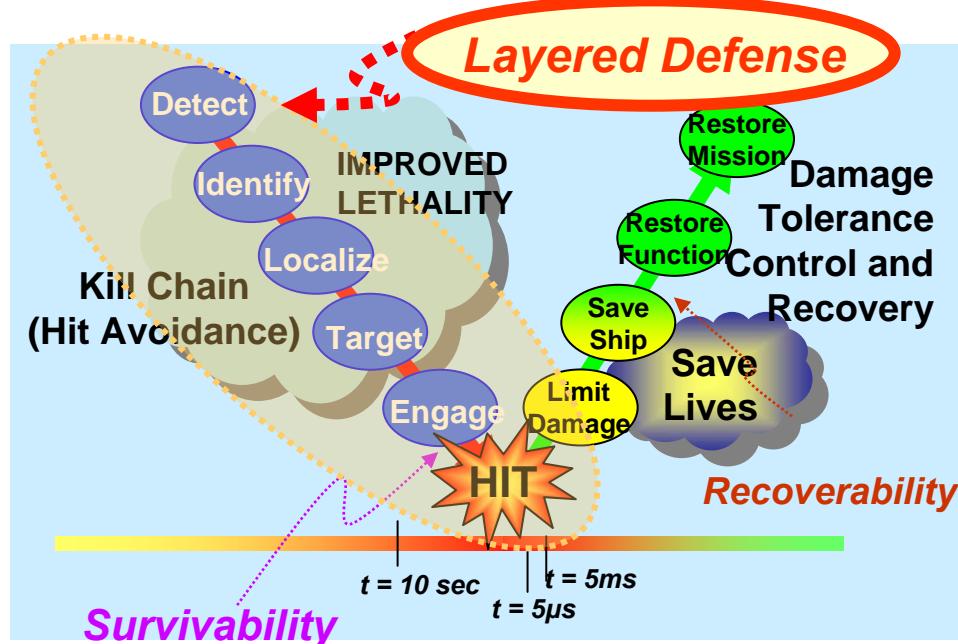
- Threat weapon tracking
- Automated decision making
- Low False alarm rate 360 degree detection
- Hard kill and soft kill against threat kinetic weapons
- Increase standoff to outside threat damage range
- Directed energy weapons for speed of light engagement
- Counter-LO

Survivable Platforms

- Advanced materials in platform construction
- Damage tolerant platform architectures
- Automated damage control focusing
- Advanced materials for self healing platforms

Force Protection

- Anti-swimmer technology
- Detect and determine threat intent
- Non-lethal response



Key Research Topics

- Signature Control (LO/CLO)
- Undersea Weaponry
- Torpedo Defense
- Directed Energy
- Survivable Platforms Structures
- Functional Materials
- Electro-Optics
- Solid State Electronics
- EW Attack
- ISRT – EM
- Expeditionary Force Protection
- Non-Lethal Weapons



Future Naval Capabilities

The **Future Naval Capability** program is aligned with the pillars of Naval Power 21, and focuses on providing enabling capabilities to close warfighting gaps.

Examples of current (FY07) enabling capabilities and corresponding products in execution:

| | FY05 | FY06 | FY07 | FY08 |
|---|------------|------------|------------|------------|
| Products in Execution | 129 | 119 | 114 | 112 |
| Product Transitions | 31 | 27 | 48 | 24 |
| Enabling Capability Transitions | 5 | 3 | 10 | 11 |
| Enabling Capabilities in Execution | 36 | 37 | 39 | 48 |

| Pillar | Enabling Capability | Products |
|-------------------------------------|---|--|
| Sea Shield | <i>Mine Countermeasures</i> | Communications and Navigation Aids for MCM Operations, Buried Mine Sensor Development for Detection and Classification of Buried Sea Mines |
| | <i>Over-the-Horizon Missile Defense</i> | Distributed Weapons Coordination, Advanced Area Defense Interceptor, Distributed Sensor Coordination |
| | <i>Defense of Harbor against Asymmetric Threats</i> | Intelligent Video Surveillance, Underwater Threat Neutralization, Passive Acoustic Fiber-Optic Array for Swimmer Detection, Terminal Swimmer Detection and Targeting |
| Sea Strike | <i>Advanced Naval Fires Technology</i> | Adaptive Expeditionary Maneuver Warfare System, Advanced Fires Coordination Technology, Advanced Gun Barrel Technology, Advanced Target Acquisition Sensing Through Walls, Detect and ID Facilities, Decision Aids |
| | <i>Transparent Urban Structures</i> | Scalable Effect Weapon Concept Development, Indirect Prototype (Scalable Effect) |
| | <i>Modular Scalable Effects Weapons</i> | |
| Sea Basing | <i>Sea Base Mobility and Interfaces</i> | Small to Large Vessel At-Sea Transfer Sea Base Connector, High Speed Seabase-to-Shore Connector, High Rate Vertical / Horizontal Material Movement, High Lift Density Air Interface Ramp Technologies, Intra-Connector Material Handling |
| | <i>Surface Connector Vehicle Transfer</i> | |
| FORCENet: | <i>Marine and UxV Tactical ISR</i> | Dynamic Replanning/Autonomous Vehicle Control, Fully Integrated Advanced Demonstrator Engine, Multi-Vehicle Cooperation / Targeting, Multi-Vehicle Networking / Comms Software |
| | <i>Global Information Grid-Compliant Networking</i> | High Altitude Airborne Relay and Router Package, Integrated, Autonomous Network Management, Intra-Battle Group Wireless Networking Block II |
| Enterprise/Platform Enablers | <i>Compact Power Conversion Technologies</i> | Multi-Function Motor Drive, BiDirectional Power Control Module, Power Management Controllers |
| | <i>Maintenance Reduction Technologies</i> | Improved Non-Skid Coatings, High Performance Topside Coatings, Improved High Ship Rudder Coatings |



Making an Impact Today

Modular Hybrid Pier

Modular, double-deck pier constructed of new corrosion-resistant concrete

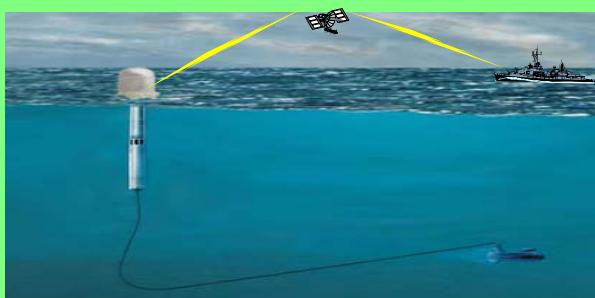
- Demonstrated in FY05
- Transitioned to P327/N46 in FY07



Next Generation Submarine Comms at Depth

Two-way comms support submarine comms at depth

- At sea test in late FY07
- Transitions to PEO C4I PMW770 in FY08



Intra-Battle Group Wireless Networking

High bandwidth, line-of-sight, wireless network within a battle group using existing advanced digital network system

- Block II transitioned to PMW160 in Dec 06
- Deployed on *John C. Stennis* strike group Jan 07

QuikClot

Hemostatic agent that almost instantaneously stops severe arterial bleeding

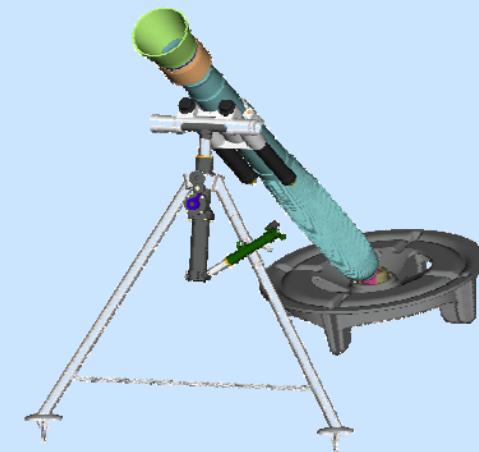
- Original product already in battlefield use with Marines
- FDA approval for Advanced Clotting Sponge expected in late FY07/early FY08



Lightweight Mortar System

Developed lightweight 81mm and 60mm mortar tubes base plates, and bipod assemblies

- Lightweight 81mm gun tube design transitioned FY06
- Lightweight 81mm bipod and base plate and 60mm mortar systems designs transitioned FY07





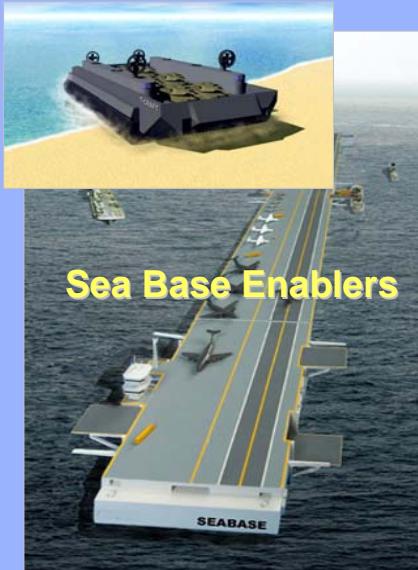
Innovative Naval Prototypes

Current INPs

Electromagnetic Rail Gun



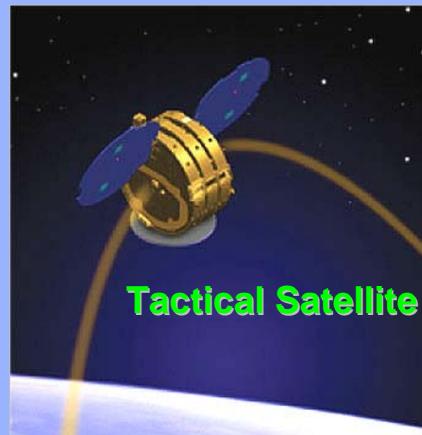
Sea Base Enablers



Persistent Littoral Undersea Surveillance



Tactical Satellite

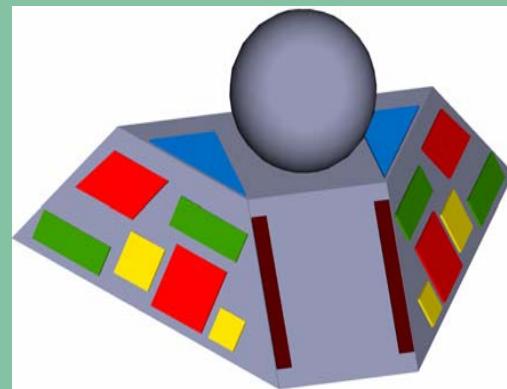


Potential INPs

Free Electron Laser

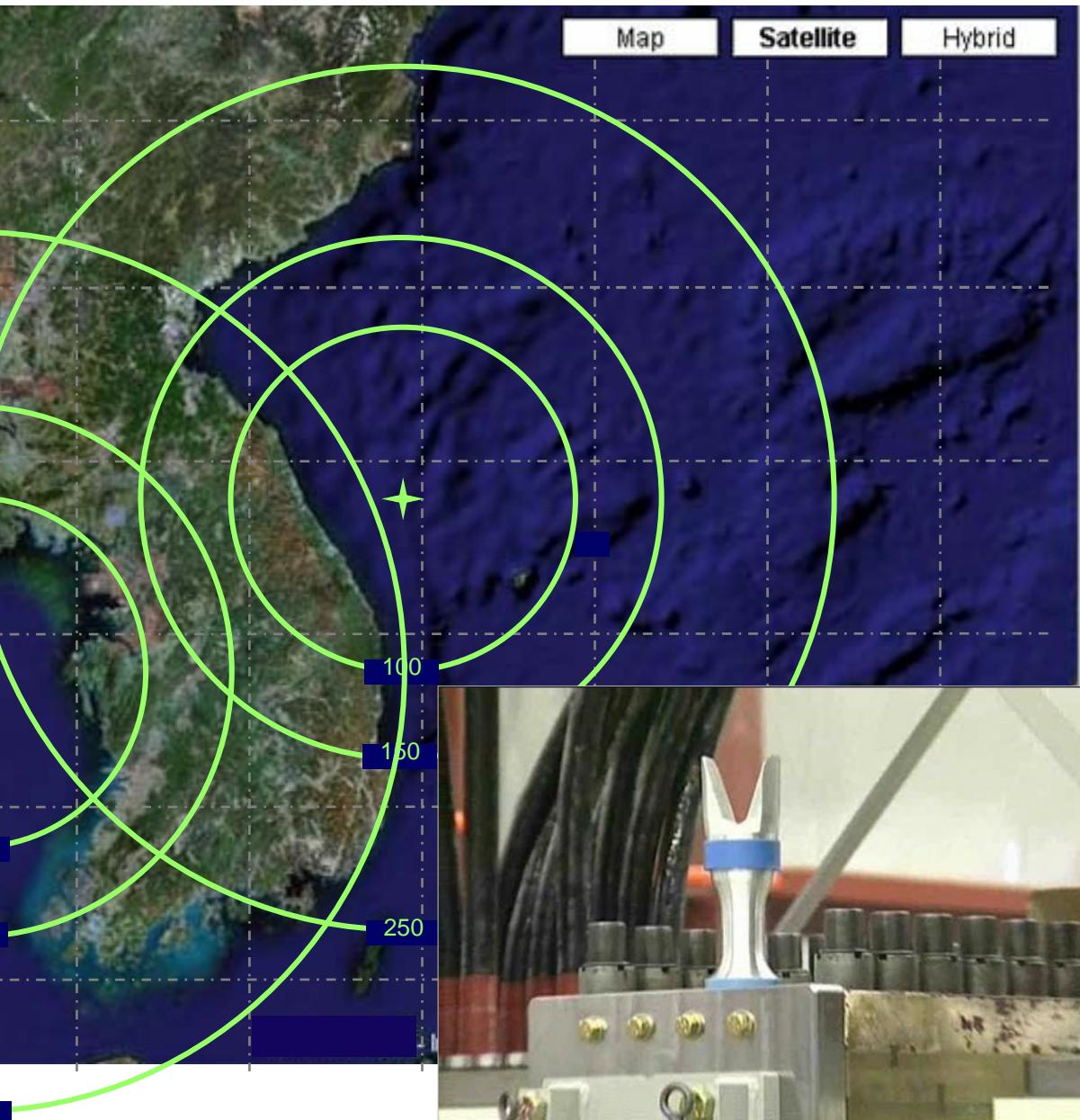


Integrated Digital Apertures and Array Radars





Electromagnetic Rail Gun



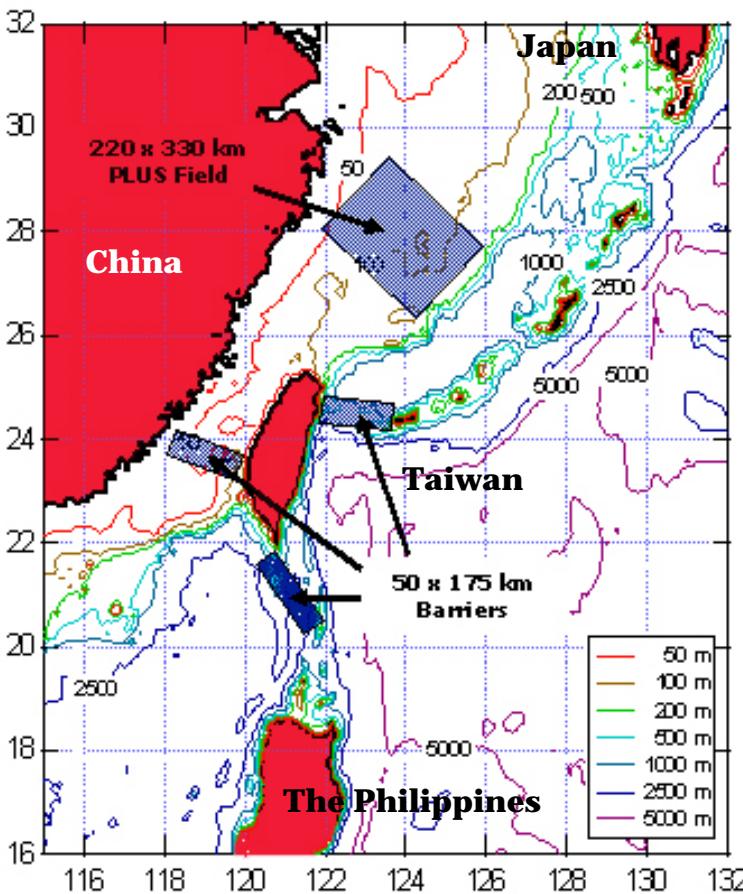




Persistent Littoral Undersea Surveillance (PLUS)

Mission:

Hold-at-Risk ASW strategy requires effective undersea surveillance against multiple, quiet targets over large littoral areas (100 x 100 nm) for months



Game Changing

- Inverts ASW asymmetry using autonomous, mobile, controllable sensor/weapon network
- Adapts to environment, targets, and threats
- Persists clandestinely for months
- Autonomous self deployment

Innovative Elements

- Autonomous, cooperative behavior among structured, mobile sensors (gliders, mobile scanning arrays, intervention units)
- Feedback control to meet operational detection thresholds
- Adaptive target closures yielding actionable kill chain



A Swiftly Changing Planet



- In an era of increasing globalization, new technology is more readily available—and more quickly—than ever before
- The natures of “combatant” and “weapon” are changing, and new challenges can come from anywhere in the world

- We must accept the fact that adversaries will use our technology against us
- To stay competitive on tomorrow’s battlefields, we must:

- **Ensure** our people and research enterprises are more innovative
- **Maintain** our technological advantage





Questions?



If technology doesn't seem like magic—it's probably obsolete.